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# A Framework for an Agricultural Policy Model for India

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Kirit S. Parikh

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## Preface

The central objectives of the research in IIASA's Food and Agriculture Program are to:

- evaluate the nature and dimensions of the world food situation;
- identify the underlying factors;
- investigate alternative courses of policy action at the national, regional and global level that may alleviate existing and emerging food problems in years ahead.

The problems of production, distribution and consumption of agricultural products vary according to the particular country, as does the nature and effectiveness of the specific policy action adopted. Therefore the starting point in our research program is the modelling of a national Food and Agriculture system. The national models are to be descriptive policy models which are also helpful in the exploration of international interactions.

This memorandum describes the framework of the model for India and is the first in a series describing the various national models being developed as a part of the research in the Food and Agriculture Program. This framework focuses on the problems and policies which are of particular concern to India, and also to other developing countries.

Summary

A framework for an agricultural policy model for India is described. The broad objective is to construct a descriptive, computable model with which one can:

- evaluate the consequences of various government policies which have been tried from time to time and some which have been suggested but not yet tried; and

- examine these policies in the context of the open economy of India which operates in the setting of bilateral, multilateral, and international cooperation, aid and trade.

The model is structured to both reflect the agricultural scene in India and be computable within the availability of empirical information.

The importance of various objectives of the government policies and the instruments of policies which are employed are identified following a brief examination of the agricultural and general economic scene in India.

In the model the economy is represented by three broad production sectors; (i) agriculture, (ii) urban non-agriculture and (iii) rural non-agriculture. Though the outputs of rural and urban non-agriculture sectors are not distinguished both these sectors have their own production functions reflecting the costs of decentralization.

In the agricultural sector a number of commodities are distinguished. Separate production functions are to be prescribed for these commodities for different agro-climatic zones. Farmer's decisions of allocation of inputs and factors are endogenous and are based on an optimizing programming framework.

Livestock operations are also endogenous and are determined in a one period programming model. A number of livestock products are differentiated.

Farmers and livestock operators are pricetakers and their profits maximizing behaviour determines the levels of output.

The economy is an open economy and trade of both agricultural and non-agricultural outputs are permitted.

Income generation is endogenous. The income distribution is partially affected by the selected technique of production. However, income distribution in the agriculture sector is determined by the distribution of land holdings, parameters for which are exogenously prescribed.

Demand for various prices are determined in the exchange equilibrium model where the endowments are traded by the various consumers who maximize their utilities. The exchange takes place under the influence of government policies in regard to taxes and international trade and tariffs.

There is no money in the model which can be held as a store of value. However, stocks of physical goods can be held. Savings and investment decisions are endogenous.

There is a government sector which can operate a number of policies. It imposes tariffs and subsidies on trade, operates a bufferstock of agricultural products, which are procured at announced prices. It determines support prices and operates a food rationing system for urban population. The various operations of the government have to be carried out within its income. Government policies are determined by its objectives.

The model is to be solved sequentially from period to period. Some policies however, can be determined appropriately only in a long term context. These are assumed to have been so determined, exogenous to the model. In fact, simulation runs of the model could help in determining some of these policies.

# A Framework for

# An Agricultural Policy Model for India

Kirit S. Parikh

## INTRODUCTION

In building this model our broad objective is to build a descriptive, computable model with which one can

1) evaluate the consequences of various government policies which have been tried from time to time and some which have been suggested but not yet tried; and

2) examine these policies in the context of the open economy of India which operates in the setting of bilateral, multilateral, and and international cooperation, aid and trade.

The model is structured to both reflect the agricultural scene in India and be computable within the availability of empirical information.

We first examine very briefly the agricultural and general economic scene in India. This will help to identify the importance of various objectives of the government policies and the instruments of policies which are employed. The broad framework of the model constructed is then described.

## 1. A BRIEF DESCRIPTION OF THE INDIAN AGRICULTURAL SCENE

The importance of agriculture in India can be seen from the fact that at present nearly 45 percent of the GNP is generated in this sector. The part of the population which depends on agriculture (78.2 million in 1971) constitutes 43.3 percent of the workers in the country. Another 26.3 percent of workers are agricultural labourers and 2.4 percent depend on livestock, fishing and plantations operations. In addition agriculture is also an important sector because a significant segment of the population receives an inadequate amount of food. Estimates of the number of people below the poverty-line in rural areas in 1968-69 range from 43 percent [Minhas (1970)] to 54 percent [Bardhan (1973)] of the population. Here, poverty-line, was a per capita consumption of Rs 200 (1960-61 prices) per year for rural areas. The poverty was based on the recommendations of a distinguished group of experts which considered the minimum income required to provide adequate food and clothing. These data are given in Table 1.

Yet even the average per capita availability of food in India has been barely adequate nutritionally. When income distribution, and consequently the distribution of food, is taken into account increased food production and its equitable distribution accross the population are important objectives of government policy. Appropriate development of the agriculture sector can help in achieving both these goals.

*I wish to thank M. Keyzer and A. Rudra for many fruitful discussions.

The productive resources of Indian agriculture consist primarily of land, animal power and human labour. Some key indicators of the agricultural sector are shown in Table 2. The net sown area is around 140 million hectares of which about 31 million hectares are irrigated. The gross sown area is around 170 million hectares.

Cultivation is mainly based on animal power and human labour and use of mechanical equipment is marginal. In 1972 there were 73.9 million working cattle and 8 million working buffaloes. There were less than 150,000 tractors in 1971 and the consumption of electrical energy was less than 30 kwh per cropped hectare. The consumption of chemical fertilizers is less than 15 kg of Nitrogen per hectare.

The production of foodgrains in 1975-76 is estimated to be around 114 million tonnes. The estimated productions of other food items are also given in Table 2.

Considerable potential exists for agricultural growth, especially through the development and wider adoption of high yielding varieties, increased use of chemical fertilizers and pesticides and development of irrigation. These, however, require investment, research and extension. The availability of resources for agricultural development has to be examined within the context of the growth of the overall economy.

The size of land holdings are very small and range from less than a hectare to a few tens of hectares. The average size of an ownership holding is less than 2 hectares per land owning household and the average size of operational holding is less than 25 hectares per operating household.

Agricultural development must benefit the millions of cultivators with very small land holdings as well as the millions of landless agricultural workers. The benefits of new technology must reach them. Such considerations of equity will affect the strategy of development.

Tenancy reform and land-ceiling legislation was passed in India many years ago. However, the implementation of such acts have been inadequate. A crop-sharing but not cost sharing tenant farmer would use less of the inputs such as fertilizer than an owner cultivator. The yield per hectare also seems to be higher for smaller farmers. Thus redistribution of land has been advocated for increasing agricultural output as well as for promoting equity.

There has been a considerable amount of argument among economists about the existence of surplus labour in Indian agriculture. In any case the scope for absorbing more labour in agriculture is limited and, with increasing population, the non-agricultural employment must grow at a faster pace if the condition of the agricultural population is to improve.

The development of the industrial sector has resulted in considerable urbanization and migration from rural areas. The urban infrastructure has not kept up with the population and the quality of life for the poor in urban areas has deteriorated severely A policy of decentralized industrial development could be of considerable value.

The Indian agriculture is dependent to a large degree on the monsoon and fluctuations in it cause significant variations in the output from year to year. In bad years the government has imported large urban areas. The government procures foodgrains from farmers for running this public distribution programme.

The prices at which foodgrains are sought to be procured from farmers have been below the market price in bad years and above it in very good years. The government has also tried to prevent free movement of foodgrains in the country in order to seal off surplus areas and facilitate procurement. In good years, this price has acted as a support price for the farmers.

The sale price in the urban ration shops has sometimes been lower than the government's cost and has thus provided a subsidy to urban consumers. A low stable food price is desired by the politically more vocal urban population.

The need to import large amounts of foodgrains in bad years can also make the government susceptible to external political pressures.

A bufferstock policy coupled with the policy of public food grains distribution can help in evening out food prices in containing inflation and in eliminating the need for large imports in certain years.

In short, the problems of Indian agricultural policies are how to increase productivity for a land scarce, labour surplus, largely rain dependant agriculture dominated by millions of farmers with small sized land holdings in a poor country where scarce resources are required for developing other sectors of the economy as well. In addition, the income distribution is such that a large part of the increasing population does not get even a nutrititionally adequate minimal diet. The development of the economy, and the agricultural sector, have to be realized while attempting to meet the basic needs of the poor.

From this brief description of the Indian agricultural scene, the objectives of government policy and the instruments which should be built into the model emerge. To these we now turn.

TABLE 1 Population and Income in India

| | |
|---|---|
| Population on 1.4.1971 (in millions) | 548 |
| Urban | 109 |
| Rural | 439 |
| No. of Workers (in 1971 in millions) | 180 |
| In agriculture | 130 |
| cultivators | 78 |
| land-less labour | 47 |
| livestock, fishing, plantations, etc. | 4 |
| Net national product per capita (Rs. 1970-71) | 640.1 |
| Share in total consumption of top 10% (rural 1967-68)* | 22.6% |
| Share in total consumption of bottom 10% (rural 1967-68)* | 3.5% |
| Nutritional Levels** | |
| Calories/consumption/person/day | 1940 |
| Calories/requirement/person/day | 2210 |
| Protein/consumption in gms/person/day | 47.9 |
| Protein/requirements in gms/person/day | 36.8 |

TABLE 2 Some Indicators of Agricultural Sector in India

| | |
|---|---|
| Land (million hectares 1971-72) | |
| Net sown area | 139.4 |
| Gross sown area | 164 |
| Net are irrigated | 31.6 |
| Gross area irrigated | 38.6 |
| Average holding (hectares, 1961-62) | 2.63 |
| Draft animals (millions, 1972) | |
| Working cattle | 74.9 |
| Working buffaloes | 8.0 |
| Tractors (millions, 1972) | .143 |
| Fertilizer used (million tons of nutrients, 1971-71) | |
| Nitrogen | 1.760 |
| Phosporous | .564 |
| Potassium | .304 |
| Production | |
| Food grains (million tons, 1975-76 provisional) estimate) | 114 |
| Animal products (million tons, 1971) | 3 |
| Milk (million tons, 1971) | 21 |
| Potatoes and tubers (million tons, 1968-69) | 10.84 |
| Vegetables (million tons 1961-62 ad hoc est.) | 1.45 |
| Fruits (million tons, 1961-62 ad hoc estimates) | 12.33 |

* Planning Commission, Fourth Five Year Plan 1969-74, 1969

** Based on FAO Food Balance Sheets, from R.D. Narain, "Production and Food Supply" in The Man/Food Equation, F. Steele and A.Bourne (eds), 1975 Academic Press.

## 2. OBJECTIVES OF GOVERNMENT POLICY

The broad objectives of agricultural policy can be described as 1) growth, 2) equity, 3) stability and self-reliance, and 4) ecological sustainability.

These objectives are important and motivate many government policies.

### 2.1 Objective of GROWTH

The growth of national economy is an obvious primary objective for a poor country. The country has a mixed economy where planning commission sets sectoral targets and the framework for the development of the economy. Some sectors of the economy are developed by the public sector. Public policy is important in promoting savings, investment and growth. This can be seen from the targets set for the fifth five year plan for savings.

| | 1973-74 | 1978-79 |
|---|---|---|
| Savings/GNP | 12.2% | 15.7% |
| public sector | 2.8% | 6.0% |
| private sector | 9.4% | 9.7% |

In addition to the objective of mobilizing savings, government policies are also important in their efficient allocations in promoting growth.

### 2.2 Not just Growth but Growth with EQUITY

In a country where 40 to 50 percent of the population is below the poverty line, meeting the minimum needs of the poor has to be an important objective even when it might conflict with the objective of growth. With the income distribution as shown in Table 3, distribution of income or at least pursuing a strategy of growth which promotes distributional objectives is desirable, and the model should permit analysis of policies which promote these ends.

TABLE 3 Income Distribution (1963-65)

| Decile Group from Bottom | Percentage Share of Disposable Income |
|---|---|
| 0-10 | 3 |
| 10-20 | 4 |
| 30 | 5 |
| 40 | 6 |
| 50 | 6 |
| 60 | 7 |
| 70 | 9 |
| 80 | 12 |
| 90 | 13 |
| 90-100 | 35 |
| Bottom 20% | 7% |
| Top 20% | 48% |
| Lorenz Ratio | 0.375 |

Source: Ojha and Bhatt (1974)

## 2.3 Growth with Equity and STABILITY

The dependence of Indian agriculture on rain can be seen in the fluctuations of the net national product shown in Figure 1. The large dips in 65-66, 66-67 and 72-73 are all due to bad monsoons. When crops fail per capita income falls drastically, food prices rise and the poor suffer even more. Moreover, instability of prices and inflation disrupt confidence and growth. Thus price stability and particularly, food price stability is necessary for equity, growth and even political stability.

Moreover, if food aid has to be sought, the country becomes susceptible to external political pressures. Thus the government might reasonably consider stable and self-reliant agricultural and economic growth as an objective for political survival.

## 2.4 SUSTAINABLE Growth with Equity and Stability

Preserving the quality and productivity of the land are essential objectives for the land intensive agriculture of India. Land is scarce and there is virtually negligible possibility for bringing additional land under cultivation. Substantial deforestation has taken place over the past 30 years by the large scale use of firewood for fuel and the expansion of cultivated area. This has accelerated erosion. Sustainability of land quality can no longer be taken for granted, and preserving it becomes an important objective of government policy.

With the limited capacity for extending land under cultivation, the country would have to go increasingly towards more intensive culitivation with chemical fertilizers, irrigations and newer varieties in place of traditional,local,ecologically adapted and naturally evolved varieties. Preserving the sustainability of agricultural productivity under such a changed regime should also be an objective of considerable importance.

## 3. INSTRUMENTS OF GOVERNMENT POLICY

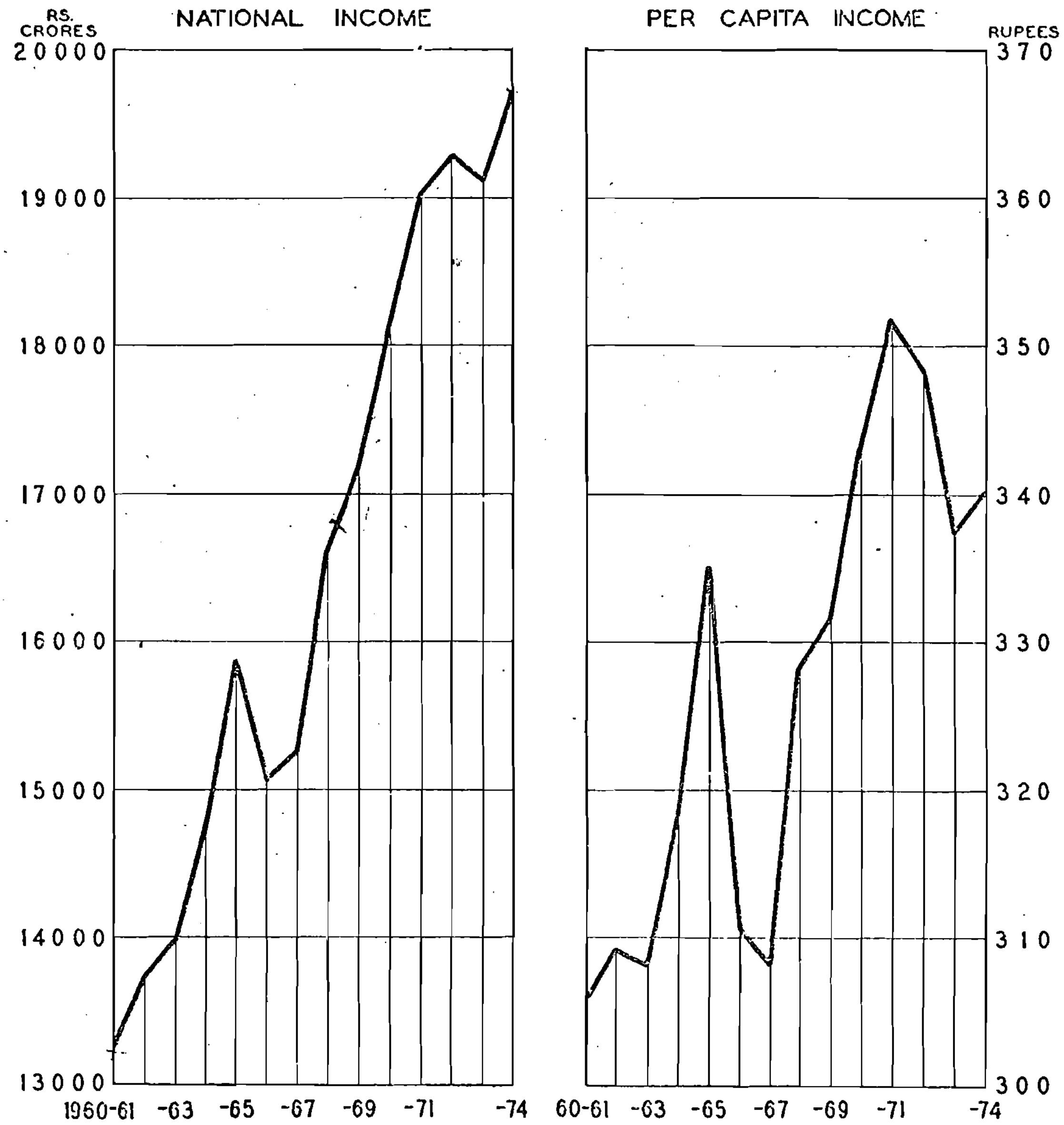
The policy instruments available to realize these goals are as follows:

| Objective: | Instruments |
|---|---|
| (1) Growth | (a) Pricing of inputs and outputs<br>(b) Acreage control<br>(c) Extension work<br>(d) Irrigation, land and infra-structure development<br>(e) Research Support |
| (2) Equity | (a) Land reforms & redistribution<br>(b) Procurement of part of surplus production for redistribution in fair price shops leading to multiple prices and markets<br>(c) Dispersal of industrial activity |

FIG. 1. NET NATIONAL PRODUCT [NATIONAL INCOME]

(AT 1960-61 PRICES)

REVISED SERIES




MINISTRY OF FINANCE, ECONOMIC DIVISION.

MGIPND-PLW-323/5/Fin/74-75-chart 2

| Objective | Instruments |
|---|---|
| (3) Stability and self-reliance | (a) Bufferstock operations for price stability<br>(b) International trade policy<br>(c) Development of irrigation<br>(d) Limit extent of trade through buffer stock operations |
| (4) Ecological sustainability | (a) Limit monoculture and specialization<br>(b) Restrict input intensities<br>(c) Promote conservation practices. |

Though the policy instruments are classified by the principal objective behind it, the instruments affect other objectives as well, sometimes positively and sometimes adversely. The qualitative directions of the effects of policy instruments on various objectives are indicated in Table 4. For example, take food aid. If large amounts of food aid are available, the government can distribute more food in fair price shops promoting equity; can operate a buffer stock to maintain food price stability. On the other hand reliance on food aid might adversely affect political self reliance and stability. Also the lower price of food may discourage farmers from producing more food in future years and thus affect growth adversely. On the other hand food aid provides resources in the hands of the government which can be used to promote a larger programme of investment which can accelerate growth.

It is because the policies interact and affect various objectives differently that they need to be evaluated in a quantitative system model. To be useful the model should permit testing of the various policies within the constraints in which policies are made.

The constraints on the government policy are due to the limited availability of domestic and foreign exchange resources, and the availability of administrative competence to implement the policies.

The model for India that is outlined here identifies separately the various policy instruments so that their effectiveness can be studied.

The following instruments in particular, are differentiated:

| | |
|---|---|
| (1) Trade Prices and Tariffs | (a) Tariffs on international trade as difference between world price and domestic free market price<br><br>(b) Ceilings on imports/exports of different commodities |

| | |
|---|---|
| (2) Domestic Price of Agricultural Products | (a) Support or procurement price |
| | (b) Fair-price shops or issue price for rationing |
| (3) Buffer Stock and Rationing Operations | (a) Desired level of stock of agricultural products at end of period t |
| | (b) Amount distributed in shops in period t |
| (4) Taxes on Agriculture | (a) Land tax<br>(b) Taxes on use of non-agricultural inputs such as fertilizers, pesticides, etc. |
| (5) Land Reforms | (a) Parameter for distribution of land holdings |
| | (b) Fraction of land cultivated by tenants and ceiling on rent paid by them. |
| (6) Mobilization of Savings & Allocation of Investments | (a) Income and excise tax rates<br>(b) Subsidy for location of industries in rural areas<br>(c) Investment allocation fractions for different sectors. |

## 4. THE GENERAL STRUCTURE OF THE MODEL

The economy is represented by three broad production sectors; (i) Agriculture, (ii) Urban non-agriculture and (iii) Rural non-agriculture. Though the outputs of rural and urban non-agriculture sectors are not distinguished both these sectors have their own production functions reflecting the costs of decentralization.

In the agricultural sector a number of commodities are distinguished. Separate production functions are prescribed for these commodities for different agro-climatic zones. Farmer's decisions of allocation of inputs and factors are endogenous.

Livestock operations are also endogenous and the various livestock products are differentiated.

Farmers and livestock operators are pricetakers and their profit maximizing behaviour determines the levels of output.

The economy is an open economy and trade of both agricultural

## TABLE 4. EFFECTS OF POLICIES ON DIFFERENT OBJECTIVES

EFFECTS ON OBJECTIVE

| POLICY INSTRUMENT | GROWTH | EQUITY | STABILITY | SUSTAIN-ABILITY |
|---|---|---|---|---|
| INVESTMENT LEVEL | ▲ | ▼ | ▼ | |
| INCOME TAX | ? | ▲? | | |
| INDIRECT TAX | ▲ | ▼ | ▼ | |
| IRRIGATION | ▲ | ▼ | ▲ | ▼ |
| PROMOTE HIGH YIELDING VARIETY | ▲ | ▼ | ▼? | ▼ |
| FERTILISERS | ▲ | ▲▼ | | ▼ |
| MECHANISATION | ▲? | ▼ | | |
| LAND CEILING & REDISTRIBUTION | ▲▼ | ▲ | ▲▼ | ▲▼ |
| TENANCY REFORMS | ▲ | ▲ | ▲?▼ | ▲?▼ |
| PUBLIC FOOD DISTRIBUTION | ▼ | ▲ | ▲ | |
| PROCUREMENT OF FOOD GRAINS | ▼ | ▲ | | |
| BUFFERSTOCK OPERATION | ▼? | | ▲ | |
| FOOD-AID | ▲▼? | ▲ | ▲▼ | |

▲ Further ojective

▼ Adverse impact

? Questionable Effect

▲▼ Effect can be either way

and non-agricultural outputs are permitted.

Income generation is endogenous. The income distribution is partially affected by the selected technique of production. However, income distribution in the agriculture sector is determined by the distribution of land holdings, parameters for which are exogenously prescribed. Demand for various products depends on income and relative prices. The relative prices are determined in the model. There is no money in the model which can be held as a store of value. However, stocks of physical goods can be held. Savings and investment decisions are endogenous.

There is a government sector which can operate a number of policies. It imposes tariffs and subsidies on trade, operates a bufferstock of agricultural products, which are procured at announced prices. It determines support prices and operates a food rationing system for urban population. The various operations of the government have to be carried out within its income. Government policies are determined by its objectives, which may be maximization of discounted consumption of the "poorest" class.

Though the model will have many periods, the solution may have to be carried out sequentially from period to period. Some policies, however, can be determined appropriately only in a long term context. These would be assumed to have been so determined, exogenous to our model. In fact, simulation runs of the model would help in determining some of these policies.

The model constructed is, in fact, a system of models which are interconnected. The various submodels and their interconnections are shown in Figure 2, which gives a schematic diagram of the model system. The sequence of solution of the various modules is shown in Figure 3.

We now describe the steps in the solution process:

a. <u>Government policies determined from long-term consideration;</u>

<u>Module G.1</u>:

Policies such as level of investments, the desired levels of prices and the structure of taxation are determined in this module.

It is assumed that a longterm development plan has been made and that the aggregate level of investment for each year has been prescribed. This is treated as the target level of investment.

It is assumed that there is a longterm price stabilization policy and that the desired price levels are known. These levels affect the development of the economy and simulation runs of the present model with different price levels should help determine these levels. The support and ration prices for agricultural products are also determined along with these prices.

Certain guidelines for the tax-rate structure are determined from consideration of equity. These guidelines can also be considered as policy parameters to be studied through simulation.

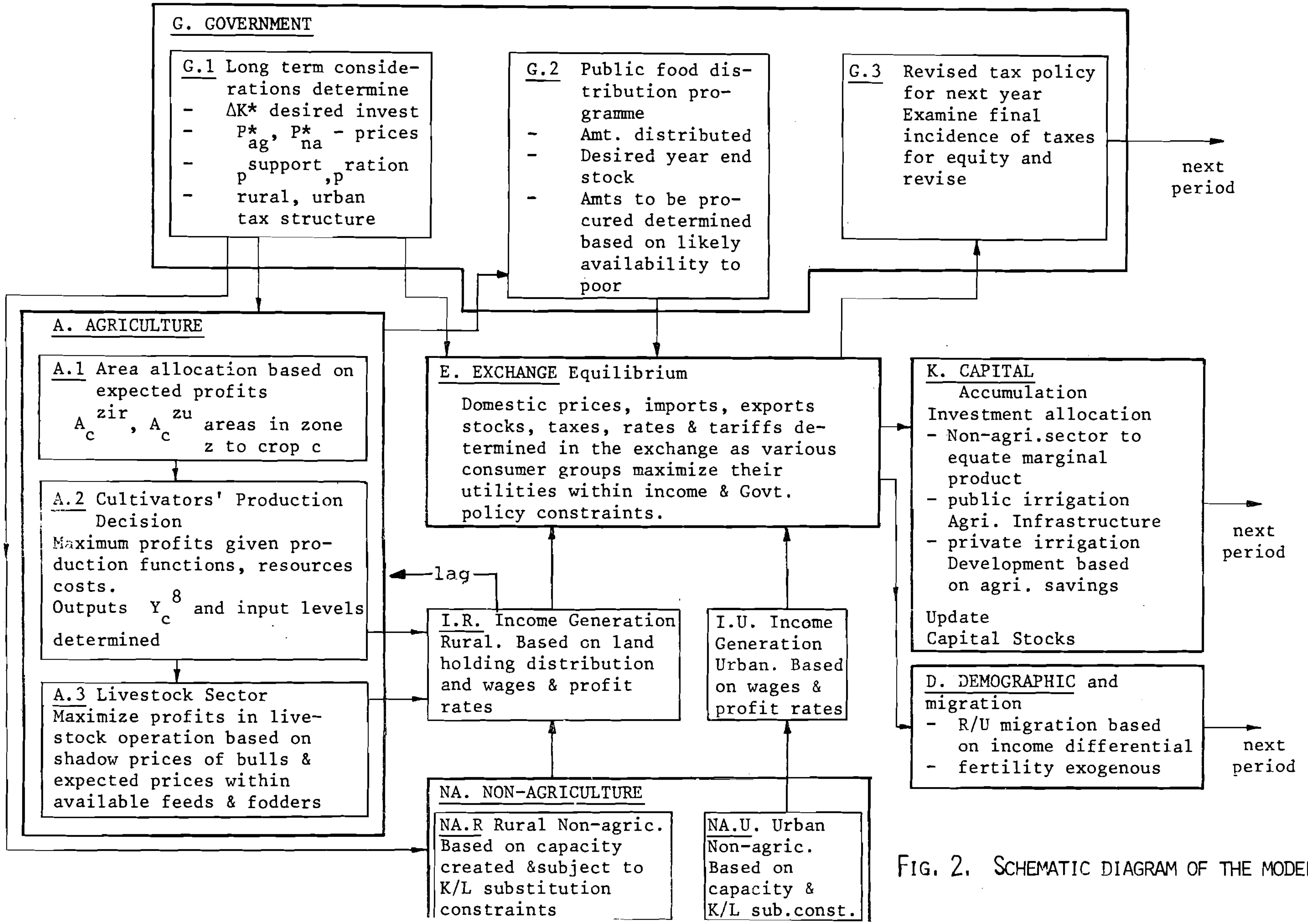



FIG. 2. SCHEMATIC DIAGRAM OF THE MODEL

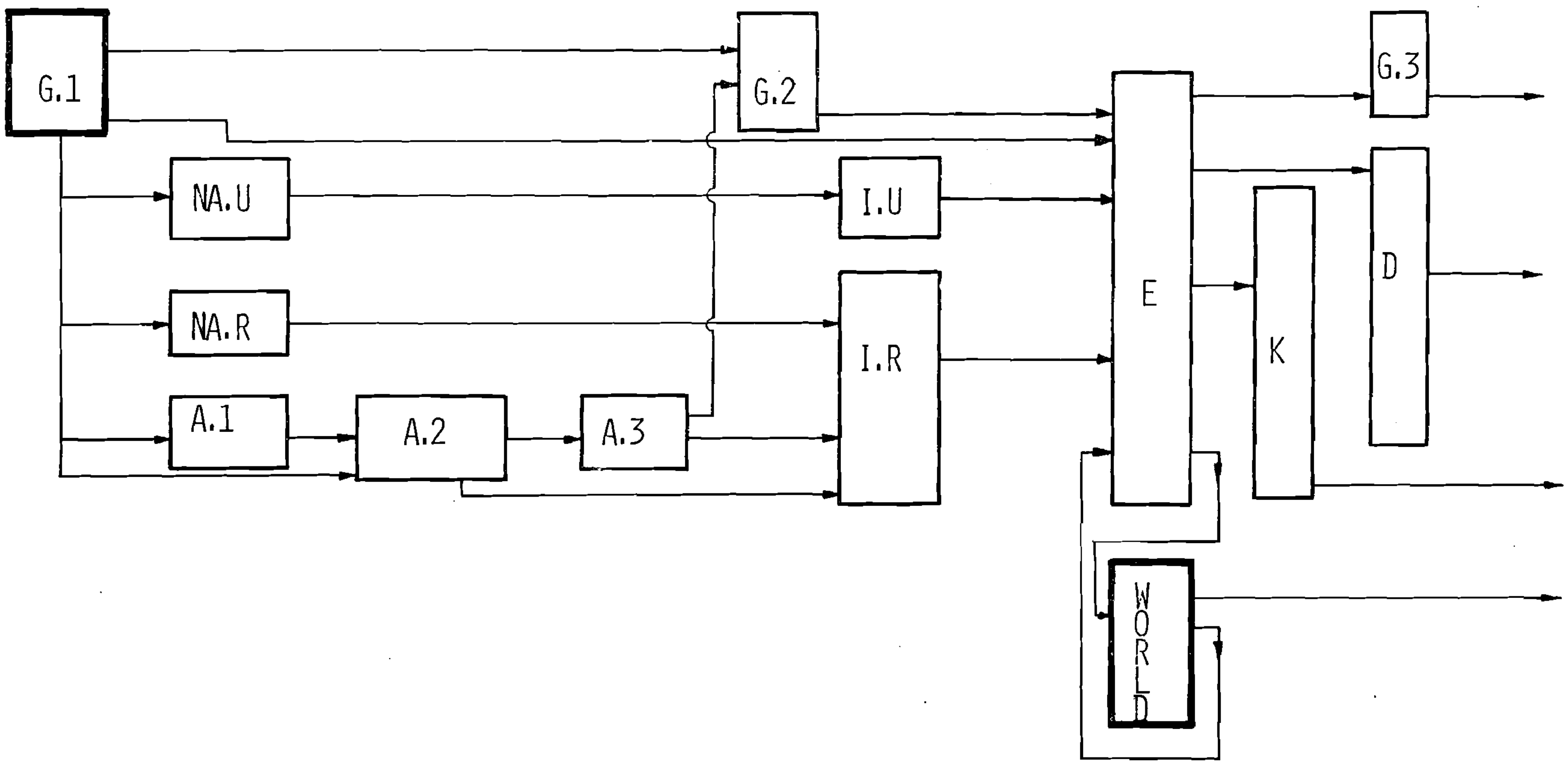



FIG. 3. THE SEQUENCE OF SOLUTION

b. Non-agriculture sectors' output; Modules NA.U and NA.R:

Based on capacity created, outputs are determined from production functions, specific to rural and urban sectors. The production functions do not permit unlimited substitution between capital and labour.

c. Allocation of land to different crops; Module A.1:

Areas of irrigated and unirrigated land to be devoted to different crops in the various zones are determined on the basis of announced support prices and expected market prices of the output.

d. Cultivators' production decision; Module A.2:

The cultivators' price expectations are formed on the basis of past prices and announced support prices. Based on these expectations, and within the constraint of the availability of operating expenses provided for in the previous years, they allocate inputs to different crops to maximize their expected profits. This determines the output of various agricultural products and the labour employed. Since bullock power is constrained by its availability, its shadow rental is also obtained when this non-linear programming problem is solved.

e. Livestock operations; Module A.3:

The outputs of fish, poultry, pig and mutton production, etc., are on the basis of price expectations.

The shadow price of bullock rental and expected milk and veal prices determine the value of animals of different ages. Based on these and the availability of greens, fodders and concentrates (using last period's prices for these feeds) decisions regarding slaughter and milk production are made to maximize profits. This programming model also yields shadow prices of animal feeds.

f. Government decisions on operation of food ration shops and bufferstock levels; Module G.2:

As the outputs of various food products are known, government forms an estimate of the number of poor people who would need subsidized food in urban and rural areas. The size of the public food distribution programme is now determined. Also the desired stock levels at the end of the year is fixed based on current stock levels and size of outputs.

The amount to be procured from farmers at the procurement (= support) prices is also determined. The difference between the desired purchases by government and the procurement amount are to be made at market prices.

g. Determination of income distribution in rural areas; Module I.R:

The agricultural income (in kind) is distributed to different classes based on the known distribution of land owned and land operated (which implies how much land is rented by each class from other classes). There is also a landless class earning only wages.

The earnings from livestock operations are distributed as per the distribution of livestocks according to land holding classes.

Wages income from rural non-agriculture is distributed as per the known distribution of non-farm wage income of rural households. Non-wage income distribution is also prescribed exogenously.

Seeds and other inputs required for next year's planned operations are set aside as savings. Non-irrigation capital use is treated as payments for depreciation and rentals. Planned expenditure for capital works next year are to be committed expenditure.

Voluntary non-tax savings for the non-agricultural sector are determined from a savings function and are prescribed as committed expenditure.

h. Urban income distribution; Module I.V:

The wages and profits are distributed as per given distributions which are treated as policy parameters.

Non-tax savings are determined from estimated savings function.

i. Computation of exchange equilibrium, consumption, prices, trade levels within quotas, and tax rates; Module E:

Consumers maximize their utilities within the income constraint of given endowments as the government tries to get the domestic prices to desired levels using taxes, tariffs, and trades within quotas and given world prices. Government target stock levels are given a lower priority than desired price levels.

Domestic price levels, amounts of exports and imports, consumption levels, public consumption, tax levels, stocks of various commodities and public savings are determined in this module where the computation of the fixed point would be carried out using an efficient new algorithm by Keyzer (1977), [see also Scarf (1973)].

j. Investment allocation and capital accumulation; Module K:

The total savings, composed of savings by different sectors and the government, are now allocated to different sectors. The public savings are first allocated for canal irrigation development, fishery development, development of infrastructure. The remaining savings are allocated to rural and urban and urban non-agriculture to obtain the same marginal product of capital in the two-sector taking into account the subsidy given to rural non-agriculture. The rate of subsidy is a policy variable determined in module G.1.

The investment allocation determines the capacities for the next period.

k. Population growth and rural urban migration; Module D:

Population growth rates in rural and urban areas are exogenously prescribed. Migration is determined by the income differential in the rural and urban areas.

l. Revision of tax policies for next period; Module G.3:

The final incidence of taxes as determined in the exchange module are examined for equity of incidence and revised so that the anticipated incidence next period has equity.

## 5. THE MODEL

For each module, the various equations are now described. In the following the subscripts "ag" and "na" stand for "agriculture" and "non-agriculture" sectors respectively. The superscript "r" and "u" refer to rural and urban sectors. The superscript "z" refers to the agro-climatic zone. A starred variable refers to an expected, desired or target level. (Various other superscripts have obvious meanings). Most variables have a time subscript which is omitted whenever there is no ambiquity about the period to which the variables refer.

The variables which refer to the agricultural sector are vectors the elements of which refer to different crops. The subscript "c" of the elements of these vectors refer to the crop or commodity.

### 5.1 Module G.1. Government policies determined from long-term considerations.

The following are assumed to be given exogenously for a given time period.

(a) Desired aggregate investment level

$S^*$ Desired investment level in period t in Rs. millions in base year prices, is determined when longterm plans of development are determined. It depends essentially on the social discount rate between the present and the future.

(b) Desired domestic prices

$[P^*_{ag}], P^*_{na}$ Desired domestic prices for agricultural and non-agricultural outputs in period t.

$[P^{support}_{ag}]$, $[P^{ration}_{ag}]$ The support price of agricultural products and the prices at which these are sold in the ration shops.

Desired domestic prices, $P^*_{ag}$, $P^*_{na}$, $P^{support}_{ag}$, $P^{ration}_{ag}$, are determined on the basis of a desired income parity between the per capita income in the rural and the urban sectors. The ratio of these incomes is a fairly stable variable and gradual changes in it may be introduced exogenously as policy objectives. The agricultural income is affected by both $P^*_{ag}$ and $P^{support}_{ag}$ whereas $P^{ration}_{ag}$ and $P^*_{na}$ determine the income in the non-agricultural sector $P^{support}_{ag}$ determined to give a certain normatively determined return to farmers. $P^{ration}_{ag}$ is also determined on the basis of paying ability of the urban poor.

(c) <u>The tax rate structure</u> as determined by the following parameters:

(i) $Tax^{direct}/Tax^{indirect}$, ratio of revenue from direct taxes to that from indirect taxes.

From a computational point of view it may be possible to realize this breakup only in an ex post sense. This point is further elaborated in module G.3.

(ii) $s^{re}$ The subsidy to rural non-agricultural sector in the form of differential excise tax, is given

Thus,

$$tax^{u\text{-}excise}_{na} / tax^{r\text{-}excise}_{na} = (1 + s^{re})$$

where

$tax^{u\text{-}excise}_{na}$, $tax^{r\text{-}excise}_{na}$ are the rates of tax Rs/Rs on non-agriculture output produced in the urban & rural sectors respectively

(iii) $s_{na}$ The rate of subsidy given to the farmers to promote the use of certain non-agricultural inputs determines the effective price to farmers

Thus,

$$P^{farmers}_{na} = (1 - s_{na}) P_{na}$$

(iv) $tax_c^{irr,z}$ The "tax" rate on irrigation supplied by government, in Rs./hectare of irrigated land in zone z devoted to crop c, is the difference between the price charged and the government's costs of supplying that irrigation.

(v) $tax^{ratio}$ The ratio of average-tax rates, is the ratio of incidence of direct tax on non-agricultural income to the incidence of tax on agricultural income.

$$tax^{ratio} = tax_{na}/tax_{ag}$$

where

$$tax_{na} = Tax_{na}^{income}/(Y_{na} \cdot P_{na})$$

$$tax_{ag} = \left\{ \sum_z tax^{land,z} A^z + \sum_c \left[ (P_c^{z,canal} - cost_c^{z,canal}) A_c^{z,canal} + (P_c^m - P_c^{support}) \cdot Y_c^{procurred} \right] - s_{na} P_{na} \cdot IN_{na} \right\} / (INC_{ag})$$

where

| | | |
|---|---|---|
| $tax_{na}$ | = | average income tax rate on non-agricultural income. |
| $tax_{ag}$ | = | average non-excise tax rate on agricultural income. |
| $Tax_{na}^{income}$ | | is total revenue from non-agricultural income tax. |
| $Y_{na} \cdot P_{na}$ | | is gross income from non-agriculture. |
| $tax_c^{land,z}$ | | is rate of land revenue tax on land in zone z. |
| $A^z$ | | is cultivated area in zone z |
| $A_c^{z,canal}$ | | is area devoted to crop c in zone z irrigated from govt. canals. |
| $(P_c^{z,canal} - cost_c^{z,canal})$ | | is the implicit tax on canal irrigation provided by the government on Rs./hectare of irrigation given to crop c in zone z. |

$P_c^m - P_c^{support}$ is the difference between market and support price of crop c.

$Y_c^{procured}$ is the amount of crop c procured by government.

$IN_{na}$ is non-agricultural output used as intermediate goods in agriculture.

$INC_{ag}$ is total income in agricultural sector.

There is no income-tax on agricultural income in India, and agricultural income can be taxed only through tax on land, inputs, irrigation, etc.

The subsidy in excise tax on rural non-agriculture, $s_e$, is to prevent migration to urban areas by giving incentive for creation of jobs in rural areas. The effectiveness of this subsidy can be evaluated from simulation runs of the model.

The incidence of indirect taxes varies with the level of expenditure rather than on the sector of origin of income whether agriculture or non-agriculture.

The tax ratios for direct and indirect taxes can be prescribed from considerations of equity on the basis of the income distribution in the two sectors and the desired progression in the tax rate.

The cost to the government of providing irrigation, $cost_c^{irr,z}$, is so determined that its operating costs and a prescribed rate of return on the capital stock in irrigation valued at replacement cost.

The desired price and tax structure as prescribed at (b) and (c) above are considered as exogenously given only as a computational convenience. In fact, various simulation runs of the model should help determine these policies.

## 5.2. Module NA. Output of Non-agriculture

Outputs of Urban and rural non-agriculture sectors are determined on the basis of expected prices and production functions which permit only a limited substitution between capital and labour. The wage rates, in Rs. per man year $w^u$ and $w^r$ in the urban and rural areas respectively, are taken to be fixed for a given period but are revised every period.

Both the urban and rural sectors are assumed to produce the same product though the two production functions are different. The rural sector's production is based on a smaller scale and is relatively "inefficient".

The output level is determined to maximize profits at expected prices.

Maximize profits, $\Pi^s$,

$$\Pi^s = P^m_{na} \cdot Y^s_{na} - w^s L^s_{na} - P^m_{ag}(t-1) \cdot IN^s_{ag}(Y^s_{na})$$

where $Y_{na}$ is output year prices in sector s,

$KU^s_{na}$, $L^s_{na}$ are the capital utilized and labour employed in production in sector s, and

$IN^s_{ag}$ is agricultural outputs used as intermediate input in the production of $Y^s_{na}$.

Subject to the following constraints:

(a) The production functions for the urban (s=u) and the rural (s=r) sectors are as follows:

$$Y^u_{na} = \left\{\alpha_1 \cdot (KU^u_{na})^{\beta_1} + \alpha_2(e^{\mu_1 t} L^u_{na})^{\beta_1}\right\}^{-\frac{1}{\beta}}$$

$$Y^r_{na} = \left\{\alpha_3 (KU^r_{na})^{\beta_2} + \alpha_4 (e^{\mu_2 t} L^r_{na})^{\beta_2}\right\}^{-\frac{1}{\beta_2}}$$

(b) The accumulated capital stock

$$KU^s_{na} \leq K^s_{na}$$

(c) Agricultural inputs required in the non-agricultural sector as intermediate products.

$$IN^s_{ag} = IN^s_{ag}(Y^s_{na})$$

This applies to both the sectors s=u and s=r. The maximizations give $Y^s_{na}$, $L^s_{na}$, $KU^s_{na}$ and $IN^s_{ag}$, and since wages are known it also gives the shares of wage earners in the output, $w^s L^s_{na}$.

5.3 Module A.I.: Agriculture sector-land and its allocation to different crops.

Land

All land will be classified by soil type and moisture availability into agro-climatic zones. These zones are further subdivided into irrigated and unirrigated land. There will be Z zones.

Unirrigated land can, through investment, be made irrigated land within the limits of irrigation potential for each agro-climatic zone.

In the first phase irrigation intensity would not be a variable. If satisfactory estimates of production functions with water input are possible, this could be introduced. The problem of water logging can also be made endogenous then.

The following are simple land accounting relations:

$$\sum_c A_c^{z,ir} + \sum_c A_c^{z,rain} \leq A^z$$

$$\sum_c A_c^{z,ir} \leq A^{z,well} + A^{z,canal}$$

$$\Delta K^{well} = \sum_z k^{z,well} \left[A^{z,well}(t+1) - A^{z,well}(t)\right]$$

$$\Delta K^{canal} = \sum_z^{z,canal} \left[A^{z,canal}(t+1) - A^{z,canal}(t)\right]$$

$$A^{z,well} \leq \bar{A}^{z,well};\ A^{z,canal} \leq \bar{A}^{z,canal}$$

(a) Acreage Decisions

There are many non-quantifiable constraints affecting the decisions on the cropping pattern and a simple profit maximizing framework to determine acreage allocations to different crops may be inadequate. We shall therefore estimate the acreage functions along the lines of the supply model of Nerlove (1958). This will be done separately for each crop, the sources of water w (canal,well, rainfed) and each zone as follows:

$$A_c^{z,w}(t) = a_o + a_1 \underbrace{P_c^{h*}(t)}_{\text{expected price}} + a_2\, P_c^{support}(t)$$

$$+ a_3 \underbrace{RW^{z*}(t)}_{\text{expected rain water}} + a_4 \underbrace{IW^{z*}(t)}_{\text{expected Irrg. Water}} + a_5\, Y_c^{levy}(t-1)$$

$$+ a_6\, A_c^{zw}(t-1) + a_7 \underbrace{t}_{\text{time trend}}$$

for w = well, canal rainfed
c = 1, .., C
z = 1, .., Z

Based on the actual harvest prices $P_c^h$ of past years the expectations of harvest price is modified.

$$P_c^{h*}(t) - P_c^{h*}(t-1) = b(P_c^h(t-1) - P_c^{h*}(t-1))$$

The unobservable harvest price variable $P_c^{h*}$ can be eliminated between these two equations and the reduced form equations can be estimated.

These will be estimated statewise (21 states) or districtwise ( ≃ 350 districts).

As a first step available estimates such as by Cummings' (1975) will be used. Cummings' estimates cover most of the states, and many selected districts and rice, wheat, barley, jute, cotton, groundnuts, sesamum and tobacco.

It is essential that the projected areas of the different crops in a zone add up to total available areas. For this purpose the supply models for the different crops should be estimated as part of one supply system. In a later phase of the model development effort such an acreage allocation system will be estimated. A simple example of such a system is analogous to the linear expenditure system of consumer expenditures.

5.4 Module A.2.: Agriculture Sector - cultivators' production decision.

Based on the expected harvest prices $P^{h*}$, the cultivators in each zone maximize their income at expected prices, $CI^*$.

Maximize $CI^*$ =

$$\sum_c P_c^{h*}(Y_c^{zir} - Y_c^{levy}) + P_c^{support} \; Y_c^{levy} \quad A_c^{zir}$$

$$+ \sum_c \; P_c^{h*} \, (Y_c^z - Y_c^{levy}) + P_c^{support} \; Y_c^{levy} \quad A_c^z - C_{cost}$$

where

$$C_{cost} = C_{inp_{ag}} + C_{inp_{na}} + C_{oth}$$

$$C_{inp_{ag}} = P_N^f \sum_c N_c^z \quad A_c^z + P_{K2O}^r \sum_c K2O_c^z \; A_c^z + P_{PH}^f \sum_c PH_c^z \; A_c^z +$$

$$V_{na}^{z,well} \quad A_{na}^{z,well} \quad + \sum_c V_{c_{ag}}^z \quad A_c^z$$

$$C_{inp_{ag}} = V_{ag}^{z,well} \quad A_{ag}^{z,well} \quad + \sum_c V_{c_{ag}}^z \quad A_c^z$$

$$C_{oth} = W^r \; L^{z,hired} \quad + P^{z,canal} \; A^{z,canal} \quad +$$

$$\sum tax^{land,c} \; A_c^z + P_{bull}^z(t-1) \; B_{(t-1)}^{z,hired}$$

| | |
|---|---|
| where $C_{cost}$ | is cost of cultivation |
| $Y_c$ | is yield per hectare of crop c |
| $P_i^f$ | is price to farmers' of $i^{th}$ input (i = N, $P_2O_5$, $K_2O$) |
| $L_c^{z,hired}$ | is net hired labour in zone z |
| $A^{z,canal}$ | is area irrigated in zone z from public canals |
| $A^{z,well}$ | is area irrigated in zone z from private sources (mainly wells. |

| | |
|---|---|
| where $v_i^{z,well}$ | is non-capital cost of inputs purchased from sector i (i = ag, na) of irrigation from private sources |
| $v_{c_i}^z \ A_c^z$ | is costs excluding cost of land, capital, labour, bullocks, irrigation and fertilizer, of cultivating crop c in zone z purchased from sector i (i = ag, na) |
| $N_c, PH_c, K2O_c$ | are N, $P_2O_5$ and $K_2O$ in kg. per hectare applied to crop c. |
| $r_{bull}^z$ | is rental cost of bullock services per hectare per period. |
| $C_{inp_i}$ | cost of inputs for cultivation from sector i (=ag, na) |

The maximum is subject to the following constraints:

(a) Production functions

$$Y_c = \alpha_o (b_c)^{\alpha_1} (l_c)^{\alpha_2} (k_c)^{\alpha_3}$$

$$Y_c = \beta_o + \beta_1 N_c + \beta_2 (N_c)^2 + \gamma_1 PH_c + \gamma_2 (PH_c)^2 + \delta_1 K2O_c + \delta_2 (K2O_c)^2$$

where $b_c^{z,w}$, $l_c^{z,w}$, $k_c^{z,w}$ are bullock hours, labour hours and capital used per hectare of crop c in zone z, water source w, (the superscripts z,w have been omitted in the above equations).

Several district studies by individual researchers are available in which estimates of costs of cultivation, yield responses to fertilizers, effects of mechanisation, etc., are studied. A survey of this material will be made to assess the usefulness of this information.

Farm management surveys initiated in 1954-55, have covered more than 40 districts by now. The crops covered include wheat, paddy, maize, gram, jowar, bajra, cotton, groundnut and sugarcane. Many of these give production functions and all give data on quantities of input used and output obtained.

For fertilizer response functions the simple fertilizer trials data would be used.

These have already been estimated by Parikh Srinivasan and Others (1975) for 8 crops and 56 agri-climatic zones for different varieties and separately for irrigated and unirrigated regions.

We will try to integrate all of these estimates.

(b) Constraint on total cost of inputs.

The costs of inputs in period t cannot exceed the amounts set aside for this purpose in the preceding period. Note that two types of inputs are distinguished those purchased from the agricultural sector and those purchased from the non-agricultural sector. These have to be procured in advance. In addition there are other costs which may be paid after the harvests. The latter do not pose any constraint.

$$C^{z}_{inp_i}(t) \leq C^{*z}_{inp_i}(t-1)$$

where $C^{*z}_{inp_i}(t-1)$ is inputs i set aside by agriculturists in the previous period.

(c) Availability of capital, labour and bullock power:

$$\sum_{w} \sum_{c} l^{z,w}_{c} \, A^{z,w}_{c} \leq L^{z}_{ag}$$

$$\sum_{w} \sum_{c} b^{z,w}_{c} \, A^{z,w}_{c} \leq B^{z}$$

$$\sum_{w} \sum_{c} k^{z,w}_{c} \, A^{z,w}_{c} \leq K^{z}$$

Net hired labour is a function of total labour used (hired plus family) and total available labour in the agricultural sector.

$$L^{z,hired} = L^{hired} \left( \sum_{w} \sum_{c} l^{z,w}_{c} \; A^{z,w}_{c}, \; L^{z}_{ag} \right)$$

Available labour and bullock hours are functions of the rural population and number of bulls.

$$L^{z}_{ag} = L \; (POP^{r,z})$$

$$B^{z} = BULLS^{z} \; (t) \, . \, h$$

The solution of this cultivator's maximization problem determines $y_c^{z,w}$, $b_c^{z,w}$, $k_c^{z,w}$, $l_c^{z,w}$ , $N_c^{z,w}$, $PH_c^{z,w}$, $K2O_c^{z,w}$, and the shadow prices on the various constraints. In particular the shadow price on bulls, $P_{bulls}^{z}$, may be noted for it is used to determine the livestock operations in the livestock module. From these we obtain the production of various crops, $Y_c^z$.

$$Y_c^z = \sum_w y_c^{z,w} A_c^{z,w}$$

In particular, the vector of animal feeds and fodder outputs are also determined.

$$\left\{Y_{feed}^z\right\} = [c_{feed,c}] \left\{Y_c^z\right\}$$

$$\left\{Y_{fodder}^z\right\} = [c_{fodder,c}] \left\{Y_c^z\right\}$$

where $[c_{feed,c}]$ is the matrix of coefficients of feed output

It may be noted that the distribution of land holdings, which affects the income distributions as explained later, does not affect the decisions on choice of techniques and inputs. To introduce these effects would mean considerable extension of the computational requirement of the model. Even then, at a later stage in the development, it is intended to introduce these effects.

The gross product is to be distributed among the following:

(i) Wage earners
(ii) Bullock owners
(iii) Land and other capital owners
(iv) To cultivators and land owners for non-agricultural inputs purchased in the previous period.
(v) To government for canal irrigation

The distribution of these shares to different income groups will be done in a subsequent module after other rural incomes are generated.

## 5.5 Module A.3: Agriculture - Livestock Operations

Compared to the food grains production of 100 million tons, the output of various types of meats is less than 1 million tons. The fishery catch is less than 2 million tons, and the production of milk is around 22 million tons. The production of eggs is .01 mill. tons.

Thus this sector is comparatively less developed at present but can be important in the future.

Though slaughter of cow is banned in many states in India, and religious sentiments do affect decisions on livestock management, there may be quite some amounts of economic logic in the actual decisions.

The model should cover operation with respect to cattle sheep, poultry, dairying and fishery. We shall now describe each of these in turn.

The Cattle Sector

Bullock are extensively used for agricultural operations. The size of land holdings is very small and individual farmers might want to have their own pair of bullocks for the convenience and appropriate timing in farming operations that own bullocks would permit. Thus the number of cows desired may be constrained by the number of working bullocks required.

Based on the various expected prices along with the shadow price of bullock in agricultural operations obtained earlier, the starting stock of animals, and the availability of feeds, the livestock operators maximize their expected profits. These consist of the net returns from milk production, slaughtered animals, bullock rentals for agricultural operations and the value of the stock surviving at the end of the period. This is posed as a programming problem.

We begin with various expected prices.

$$P^*_{feeds}(t) = f(P_{feeds}(t-1), Y_{feeds}(t))$$

$$P^*_{milk}(t) = f(P_{milk}(t-1), Y_{milk}(t))$$

$$P^*_{beef}(t) = f(P_{beef}(t-1), Y_{beef}(t))$$

$P_{bulls}(t)$ = shadow price in cultivators production decision module.

With these, the following objective function is maximized:

$$\sum_{\substack{k\\ \text{cattle}\\ \text{buffalo}}} \left\{ \sum_{\tau=0} \left[ \underbrace{P_{bulls}(t) \cdot LS_B^{k\tau}(t) \cdot b^{k\eta}(\tau)}_{\text{rental from agricultural operations}} - \underbrace{\sum_i P^*_{feed_i}(t) \cdot LS_B^{k\tau} \cdot f_{iB}^{k\eta}(\tau)}_{\text{cost of feeds}} \right.\right.$$

$$+ \underbrace{P^*_{milk}(t)\ LS_C^{k\tau}(t) \cdot m^{k\eta}(\tau)}_{\text{value of milk}}$$

$$- \underbrace{\sum_i P^*_{feed_i}(t) \cdot LS_C^{k\tau} \cdot f_{iC}^{k\eta}(\tau)}_{\text{cost of feed}}$$

$$+ \underbrace{V_B^{k,\tau+1}\ LS_B^{k,\tau} + V_C^{k,\tau+1}\ LS_C^{k,\tau}}_{\text{value of surviving cattle}}$$

$$\left.\left. + P^*_{beef}(t)\ (LSS_B^{k\tau} \cdot s_B^{k\eta}(\tau) + LSS_C^{k\tau} \cdot s_C^{k\eta}(\tau)) \right] \right\}$$

subject to:

(a) New births

$$LS_s^{ko} + LSS_s^{k,o} = \sum_{\tau=3}^{14} LS_C^{k\tau} \cdot r^k(\tau) \qquad \begin{array}{l} s = B,c \\ k = \text{cattle, buffalo} \end{array}$$

(b) Initial stock

$$LS_s^{k\tau}(t) + LSS_s^{k,\tau}(t) = LS_s^{k,\tau-1}(t-1) \text{ for } \qquad \begin{array}{l} k = \text{cattle buffalo} \\ \tau = 1,\ldots,14 \\ s = B,C \end{array}$$

(c) Feed availability

$$\sum_{\substack{k=\text{cattle}\\ \text{buffalo}}} \ \sum_{s=B,C} \ \sum_{\tau=0}^{14} f_{is}^{k\eta}(\tau) \cdot LS_s^k \leq Y_{feed_i}(t) \qquad \begin{array}{l} i=1,\ldots,3 \\ \text{for different feeds} \end{array}$$

where $LS_s^{k\tau}(t)$ is stock of livestock of type k (k = cattle, buffalo) sex s (s= bull,cow) of completed years $\tau$ at the beginning of period t which survives period t.

| | |
|---|---|
| $LSS_s^{k\tau}(t)$ | which is slaughtered on 1st day of period t, (all births are also assumed to be on the same day. |
| $f_s^{k\eta}\ (\tau)$ | is vector of feed requirements per year per animal type k of sex s of age $\tau$ under feeding regime $\eta$. |
| $b^{k\eta}\ (\tau)$ | bullock power available per working bull per year. |
| $m^{k\eta}(\tau)$ | milk production rate |
| $s_s^{k\eta}$ | beef yield rate |
| $Y_{feed}(t)$ | feeds available in period t. |
| $V_s^{k,\tau}$ | value of animal of age $\tau$ at the beginning of period t. |

The value of surviving animal is not known. It is however possible to assume a set of values $V_s^{k,\tau}$ and iterate to solve the problem. The $V_s^{k,\tau}$'s are not independent, but are related to each other.

Assuming a stationary state and a time discount rate of $\frac{1}{\Phi}$ per period the values of animals of different ages are related as follows:

$$V_B^{k\tau} = \text{Max}\left\{P^*_{beef}\ s_B^{k\eta}(\tau), \left(\frac{1}{\Phi}\ V_B^{k,\tau+1} + + P_{bull}(t)\ .\ b^{k\eta}\ (\tau) - \sum_i P^*_{feed_i}\ f_{iB}^{k\eta}(\tau)\right)\right\}$$

$$V_C^{k\tau} = \text{Max}\left\{\left(\frac{1}{\Phi}\ V_C^{k,\tau+1} + P^*_{milk}(t)\ .\ m^{k\eta}(\tau) - - \sum_i P^*_{feed_i}\ f_{iC}^{k\eta}(\tau) + V_B^{k,o}\ .\ b^k(\tau) + + V_C^{k,o}\ b^k(\tau)\right),\ P^*_{beef}\ s_C^{k\eta}(\tau)\right\}$$

for $\tau = 0,\ldots,14$
$k$ = cattle, buffalo

$$V_C^{k,15} = V_B^{k,15} = 0$$

The above set of equations are sufficient to determine all the $V_s^{k\tau}$'s, once the feed regimes $\eta$ determined (i.e. when alternative regimes are prescribed). To solve the problem an initial set of feeding regimes, $\eta$'s, are selected, the values $V_s^{k\tau}$ are determined and then the maximization problem is solved. In some cases the feeding regimes ($\eta$'s) selected in the solution may be different and iterations may be required.

The outcome of these calculations are the following:

(a) Cattle surviving and available for next period, $LS_s^{k\tau}(t)$, which also determines the availability of bullork power for agricultural operations next period.

$$BULLS(t) = \sum_k \sum_\tau b^{k\eta}(\tau) LS_B^{k\tau}(t)$$

(b) The production of milk, and beef

$$MILK(t) = \sum_k \sum_\tau m^{k\eta}(\tau)\ LS_C^{k\tau}$$

$$BEEF(t) = \sum_k \sum_\tau \sum_s s_s^{k\eta}(\tau) LSS_s^{k\eta}(\tau)$$

(c) The shadow prices of foods, $P_{feeds}$

Goats and Sheep

These provide meat, milk and wool but not draft power. Moreover these are mainly raised in arid zones and on pastures. The supply of goat milk, mutton, lamb meat and wool are estimated as functions of past prices and available land for raising goats and sheep.

$$MUTTON(t) = MUTTON\ (MUTTON\ (t-1),\ P_m^m(t-1),\ A_{pastures}(t))$$

$$LAMB\ (t) = LAMB\ (LAMB\ (t-1),\ P_L^m\ (t-1),\ A_{pastures}(t))$$

$$WOOL\ (t) = WOOL\ (WOOL\ (t-1),\ P_w^m\ (t-1),\ A_{pastures}(t))$$

$$MILK_{goat}(t) = MILK_{goat}(MILK_{goat}(t-1),\ P_{milk}^m(t-1),\ A_{pastures}(t))$$

Poultry

The supply of eggs and chicken would be estimated as function of prices.

$$EGGS\ (t) = EGGS(P^m_{eggs}(t-1),\ P^m_{eggs}(t-2),\ EGGS(t-1))$$

$$CHIC\ (t) = CHIC(P^m_{chic}(t-1),\ P^m_{chic}(t-2),\ CHIC(t-1))$$

Pigs

$$PORK\ (t) = PORK(P^m_{pork}(t-1),\ P^m_{pork}(t-2),\ PORK(t-1))$$

Fishery

The potential to increase the supply of fish from inland waters exists with scientific management of fish culture. Also as more reservoirs are built further growth should be possible.

India has a long coast line and substantial possibilities exist to increase marine fish catch from the coastal waters with some investment. And of course, for deep sea fishing much of the options available to other countries are available to India too.

Separate production functions and supply responses will be stimated for fresh water and marine fish.

$$FISH_i(t) = FISH_i\left(P^m_{fish}(t),\ FISH_i^{potential}(t)\right) \qquad i = \text{fresh water, marine}$$

$$FISH_i^{potential}\ (t) = FPOT_i\ (\underbrace{K_{fish_i}}_{\text{capital stock}}\ (t))$$

## 5.5 Module G.2: Government's - Food Distribution Programme

Given the stocks in hand, the government once it knows the output of food grains, decides on its various policies as follows:

$R_{ag}(t)$ Amounts to be distributed in ration shops are determined. Knowing the availability of food $(ST_{ag} + Y_{ag})$, and the vulnerable population which needs to be protected.

$$R_{ag}(t) = R\left((1-s_{ag}^{st})\ ST_{ag}(t-1),\ Y_{ag}(t)),\ POP^{u}(t),\ POP^{r}(t)\right)$$

where $s_{ag}^{st}$ is loss in stocks due to storage

$ST_{ag}^{*}(t)$ The desired stock at the end of the period is also determined similarly.

$$ST_{ag}^{*}(t) = S_{ag}\left(ST_{ag}(t-1), Y_{ag}(t),\ POP^{u}(t),\ POP^{r}(t)\right)$$

$P_{ag}^{ration}$
$P_{ag}^{support}$ are already determined from long-term considerations in module G.1

$Y_{ag}^{procured}$ is determined on the basis of the fraction of food grains output that government wants to command, assuming no imports.

$$Y_{ag}^{govt.} = \left(ST_{ag}(t) - (1-s_{ag}^{st})\ ST_{ag}(t-1) + R_{ag}(t)\right)$$

$$Y_{ag}^{procured} = P\left(Y_{ag}^{govt.},\ Y_{ag}, P_{ag}^{support}\right)$$

$(Y_{ag}^{govt.} - Y_{ag}^{procured})$ only when > 0 will be purchased by the government at the market price $P_{ag}^{m}$.

$r_c^s$, $f_p^s$ are amounts of commodity c to be given at the ration shops to a person in sector (rural and urban) and the fraction of population $POP^s$ to be covered by rationing, respectively. These are policy parameters but in determining these the constraints on total amounts rationed have to be observed.

$$R_c = f_p^u \cdot POP^u \, r_c^u + f_p^r \cdot POP^r \cdot r_c^r$$

The outcome of this module are the following:

$Y_{ag}^{procured}$, $R_{ag}^s$, $f_p^s$ and $ST_{ag}^*(t)$

5.6 Module I.R: <u>Rural Income, Distribution, Savings and Committed Expenditure</u>

Once the production levels are determined, the products of the rural economy have to be distributed to the different classes. The incomes generated are distributed to various groups on the basis of distribution of land holdings and the distribution of animal ownership by land holding classes. The non-agricultural incomes are distributed over the non-agricultural rural population as per a prescribed distribution. A part of the nog-agricultural income is earned as wages by agricultural households some members of which work in the non-agricultural sector. These wage income is distributed as per the prescribed fractions of available labour hours devoted to non-agricultural work by the agricultural households. Data on these various distributions are available from various sample surveys. Though it is assumed that these distributions remain stable, they could be exogenously altered in different scenarios to explore the effects of alternative land reforms or asset redistribution policies.

From the two-way distribution of households by land ownership and land cultivating classes, the amount of land leased in and out by various classes can be inferred as follows:

Agricultural households are divided into K land <u>holding</u> classes. A household in class h owns $a_h$ hectares of land. The first class consists of those households who do not own any land and so $a_o = 0$. The land is not always cultivated by the household which owns it. Thus one can also divide all the agricultural households, $H_{ag}$, into K land cultivating classes where a household in class k cultivates $a_k$ hectares of land. The two-way distribution of the households by land owned and cultivated can be represented by a KxK matrix [q] where $q_{hk}$ gives the proportion of all agricultural households owning $a_h$ hectares but cultivating $a_k$ hectares of land per households.

Such an household has leased in for cultivation $(a_k - a_h)$ hectares of land from other households. The number of households in any class hk is $H_{ag} \cdot h_{hk}$. Thus we have the following relationships for a given class h,k:

| | |
|---|---|
| Number of households in class | $H_{ag} \cdot q_{hk}$ |
| Land owned by one household | $a_h$ |
| Land cultivated by one household | $a_k$ |
| Land leased in by one household | $a_k - a_h$ |
| Potential man years available for agricultural work per household | $m^p_{kh}$ |
| Actual household labour utilized on own farm by the household | $m^o_{hk}$ |
| Hired labour employed by the household | $m^w_{hk}$ |
| Total labour employed by the household | $m^t_{hk} = m^w_{hk} + m^o_{hk}$ |
| Value of labour employed by the household at the nominal wage w | $w \cdot m^t_{hk}$ |
| Wages retained by the household | $w \cdot m^o_{hk}$ |
| Labour of the household not employed on self cultivated farm and hence available for hire | $m^p_{hk} - m^o_{hk}$ |

Wage income earned from other cultivators by the household, assuming equal probability of employment of all labour available for hire,

$$W^{hk} = \frac{(m^p_{hk} - m^o_{hk})}{\sum\limits_h \sum\limits_k (m^p_{hk} - m^o_{hk})} \sum_k \sum_h w m^w_{hk}$$

For the class h of all households owning area $a_h$ cultivating different amounts of land, we have the following:

Number of households in class h, $H^h = H_{ag} \sum_h q_{hk}$

Total land cultivated by households of class h, $A_k^h = H_{ag} \sum q_{hk} a_k$

Total land owned by the households of class h, $A_k^h - H^h a_h$

Area leased out by the households of class h, $A_{lo}^h = A_h^h - A_k^h$

$$= H_{ag} \sum_k q_{hk}(a_h - a_k)$$

Wages earned by the households of class h, $W^h$, are given by

$$W^h = \sum_k W^{hk}$$

When $W^h$ is negative the wages are paid by the households of class h.

The share of the households of class h in the agricultural products and expenditures is the sum of what they earn as owners of land area $A_h^h$ and what they earn as cultivators of land area $A_k^h$. The total products of cultivation are given by the vector $Y_{ag}^z$ and the per acre products are $\left\{ Y_{ag}^z / A^z \right\}$. The share of households of class h in the products of cultivation, $\left\{ Y_{ag}^{z,h} \right\}$, is thus

$$Y_{ag}^{z,h} = \frac{Y_{ag}^z}{A^z} \left[ (1 - t_{sp}) A_h^h + t_{sp} A_k^h \right]$$

where $t_{sp}$ is tenants share and $1-t_{sp}$ is owners share.

The feeds (including fodder) for livestock are purchased by the livestock owners from the cultivators. These are purchased at the prices $p_{feed_i}$, determined in the livestock module A.3. The total cost of feeds and fodders, $C_{ff}$, is

$$C_{ff} = \sum_i Y_{feed_i}$$

i refers to type of feed

The receipt from sale of feeds and fodder of households type h, $F^h_{rec}$, is

$$F^h_{rec} = C_{ff} \; [(1 - t_{sp}) \; A^h_h + t_{sp} \; A^h_k]$$

The cost of feeds and fodders paid by the housholds of type h, $F^h_{cost}$, are in proportion to the livestock held.

$$F^h_{cost} = \sum_i \sum_a \sum_s \sum_\tau P_{feed_i} \; f^{a\tau}_{si} \; n^h_a \; LS^{h,\tau}_a$$

where $f^{a\tau}_{si}$ is the feed type i fed to an animal of type a sex s and age $\tau$ during the period.

Bullock rentals have to be paid by the cultivators. These are taken to be in proportion to the land area cultivated. This will accrue to the livestock owners. The bullock rental paid by households type h, $B^h_{cost}$, is

$$B^h_{cost} = r_{bull} \; [(1 - t_{sc}) \; A^h_h + t_{sc} \; A^h_k]$$

where $r_{bull}$ is the rental cost of bullock services per hectare per period.

$$r^z_{bull}(t) = \frac{B^z(t)}{A^z} \cdot P^z_{bulls}(t)$$

where $P^z_{bulls}(t)$ is the shadow price of bullock hours obtained from cultivators' decision module A.2.

The bullock rentals accrue to the bullock owners. The income from livestock products is distributed as per the number of different types of animals owned by each size class h of land owners.

Let $n^h_a$ be the proportion of livestock of type a in the zone $LS^1$ held by the land ownership class h. The products of livestock of type 1 are distributed as per $LS^h_a$.

$$Y^h_{ap} = n^h_a \, LS^h_a Y_{ap}$$

a = Cattle
Buffalos,
Sheep,
Goats,
Pigs, and
Poultry.

where $Y_{ap}$ is products resulting from one animal of livestock type a.

The bullock rentals are excluded from the above as they are not traded in the exchange. The bullock rental received, $B^h_{rec}$, has to be accounted for separately.

$$B^h_{rec} = r_{bull} \cdot A^z \cdot n^h_{bull}$$

The tax liabilities and other committed expenditures of the various households are as follows:

(1) The land revenue tax has to be paid on the land to the government.

$$Tax^{z,land} = tax^{z,land} \, A^z_h.$$

In addition payments for canal irrigation to the government is made for the area irrigated from canals

$$Tax^{z,canal} = P^{z,canal} \cdot A^{z,canal}$$

These tax liabilities are distributed to the land owners and tenants just the way output is distributed. Thus households of class h have to pay as taxes

$$Tax^{h} = \left( \frac{Tax^{z,land} + Tax^{z,canal}}{A^{z}} \right) \left[ (1 - t_{sc})\, A_{h}^{h} - t_{sc}\, A_{k}^{h} \right]$$

(ii) The input requirements for next years operations have to be set aside this year. Inputs are classified into agricultural (seeds etc.) and non-agricultural inputs. Tenants and landlords share not only production but also costs though not necessarily in the same proportions. Let $t_{sc}$ be tenant's share of costs of inputs. Then the household type h has to set aside $C_{inp}^{*h}(t+1)$ for next years cultivation. The agricultural inputs are set aside in kind, whereas the non-agricultural inputs are purchased in advance during the exchange.

These costs of cultivation at expected prices, $C_{inp}^{*}(t+1)$, are determined as follows:

$$C_{inp}^{*z}(t+1) = C_{inp}^{z}\left(C_{inp}(t),\ CI^{*}(t),\ CI^{*}(t-1),\ \Delta A^{ir},\ \Delta A\right)$$

where

| | |
|---|---|
| $\Delta A^{ir}$ | is expected increase in irrigated area next period |
| $\Delta A$ | is expected increase in cultivated area |
| $CI^{*}$ | Expected income of cultivators |
| $CI$ | Actual income of cultivators. |

Cost per hectare is $c_{inp}^{*z}$:

$$c_{inp}^{*z} = \frac{C_{inp}^{*z}}{A^{z}}$$

Cost set aside by household of class h, $C^{*z,h}_{inp}$:

$$C^{*z,h}_{inp} = c^{*z}_{inp} \, [(1 - t_{sc}) \, A^h_h - t_{sc} \, A^h_k]$$

$$inp = ag, na$$

The agricultural inputs $\left\{C^{*h}_{ag}\right\}$ reduce the endowment available for exchange and consumption whereas the non-agricultural inputs have to be obtained during the exchange.

The rural non-agricultural product, $Y^r_{na}$, is first divided into two parts, wage share and returns to capital. The share of agricultural housholds in both these parts are prescribed. The wages accruing to the agricultural households are distributed in the same proportion as the agricultural wage income. Whereas the share of profits is distributed as per prescribed distribution.

The shares of non-agricultural households are distributed in prescribed proportions to different income classes.

Share of wages in the product of rural non-agriculture

$$W^r_{na} = \frac{w \, L^r_{na}}{P_{na}(t-1)}$$

Share of profits $= PR^r_{na} = Y^r_{na} - W^r_{na}$

Share of wages to agricultural households,

$$sw_{ag} W^r_{na}$$

Wage and profit incomes from rural non-agricultural sector earned by agricultural households of class h.

$$sw_{ag} W^r_{na} \cdot \frac{\sum_k W^{hk}}{\sum_h \sum_k W^{hk}} \; ;$$

$$pr^h \cdot pr^r_{ag} (Y^r_{na} - W^r_{na}).$$

Wage income of non-agricultural households of $i^{th}$ income class.

$$W_{na}^{ri} = sw_i (1 - sw_{ag}) W_{na}^{r} \qquad i=1,\dots,IC$$

Profit income of non-agricultural households of $i^{th}$ income class.

$$PR_{na}^{ri} = pr_i (1 - pr_{ag}^{r}) (Y_{na}^{r} - W_{na}^{r})$$

When all these various sources of income, expenditure and liabilities are added up, we get the resulting endowments of products for the different household classes in the rural sector. These are summarized below:

<u>Household class h</u>

(i) Vectors of agricultural endowments

$$Y_{ag}^{z,h} + Y_{ap}^{h} - C_{inp_{ag}}^{*h}$$

(ii) Other income

$$W^{h} + F_{rec}^{h} - F_{cost}^{h} + B_{rec}^{h} - B_{cost}^{h} - Tax^{h}$$

(iii) Non-agricultural endowments from rural non-agriculture

$$W_{ra}^{rh} + PR_{na}^{rh} = Y_{na}^{r,h}$$

(iv) Committed expenditure for non-agricultural inputs

$$C_{inp_{na}}^{*h}$$

## 5.7 Module I.U: Urban Income, Distribution, Savings and Committed Expenditure

The output of urban non-agriculture is distributed as per a prescribed distribution function which depends upon the level of non-agricultural output per person.

$$P(Y^u_e) = F(Y^u_{na}/POP^u)$$

where $P(Y^u_e)$ is the probability of an urban person to have an income $Y^u_e$

$POP^u$ is urban population

$Y^u_{na}/POP^u$ is average product of urban non-agriculture per urban person.

Urban voluntary savings are determined by savings functions which relate after tax income to savings. However, since tax levels as well as income (i.e. value of endowments determined by prices) are determined only in the exchange module, savings are also determined in the exchange process.

## 5.8 Module E: The Exchange Module

The endowments and incomes determined in the modules 5.5 and 5.6 are traded in this module. The exchange of these goods is affected by the trade and tax policies of the government. The consumers belonging to different classes maximize their utility function while the government attempts to realize its objectives given the world prices. The outcome of this exchange determines for each class:

(i) Prices realized and paid
(ii) Value of endowments and income
(iii) Consumption levels
(iv) Taxes paid, and
(v) Savings realized.

In addition, for the economy the following are determined:

(i) Import and export levels
(ii) Tariffs on trade
(iii) Tax rates
(iv) Government's income, and
(v) Year end stock levels

The equations of the exchange problems are presented for different actors in turn. These are followed by the constraints on the whole system. All the variables which are considered given for the exchange process (i.e. which are determined outside of it) are shown with a bar "___" on them.

(i) Consumers

(a) Utility Function

Consumers belonging to sector s and endowment class j maximize their utility function $U^{s,j}$ subject to the value of their total endowments.

$$\text{Maximize} \quad U^{s,j}\left\{C^{s,j}_{t,i}\right\}$$

where $C^{s,j}_{t,i}$ is the total consumption of $i^{th}$ good by consumers of sector s and class j.

(b) Demand System

A complete demand system implied by utility maximization subject to a budget constraint will be estimated from the data obtained from consumer expenditure.

$$C^{s}_{t,i} = D^{s}_{t,i}(P^{m}, P^{h}, E^{s}_{t})$$

where $C^{s}_{ti}$ is the total consumption of good i consisting of what is obtained from the rationshop the market and/or self consumption by producers.

$P^{m}$ is the vector of market prices which includes trade margins.
$P^{h}$ is the vector of harvest prices which are relevant for self consumption by farmers.
$E^{s}_{t}$ is the total expenditure on consumption by sector s.

The total consumption comprises of three parts

$$C^{s}_{t,i} = R^{s}_{i} + \hat{C}^{s}_{i} + C^{s}_{i}$$

where

$R^{s}_{i}$ is amount of goods i obtained from rationshop.

$\hat{C}^{s}_{i}$ is amount of goods i consumed from retained self cultivation.

$C^{s}_{i}$ is amount of goods i obtained form market.

To begin with we use a linear expenditure system implying a Cobb-Douglas utility function, such as the ones estimated by A. Rudra (1964) and N. Bhattacharya (1967).

(c) Savings

The consumer expenditure surveys do not give savings $S^{s,j}$, at the same time. Thus savings have to be deducted first from income, $INC^{s,j}$, to obtain expenditure.

$$E_t^{s,j} = INC^{s,j} - S^{s,j}$$

Part of the savings are in the nature of committed expenditure and are procured in the form of non-agricultural products.

$$S^{s,j} = S^{s,j}(INC^{s,j}) = P^m_{na} V_{na}{}^{s,j}$$

$$INC^{s,j} = I^{s,j}(\bar{Y}^{s,j}, P^m)$$

| | |
|---|---|
| $S^{s,j}$ | is the voluntary savings by class j of sector s, |
| $INC^{s,j}$ | is income of class j sector s |
| $V^{s,j}_{na}$ | is the amount of non-agricultural product obtained as voluntary savings. |

The utility maximization is subject to the income constraints.

(d) Rural Incomes

Since farmers do not have to pay the trade margins on consumpout of their own produce, these two types of consumption need to be distinguished in the income constraints.

$$\begin{aligned}
\sum_i (\bar{P}_i^{ration} \bar{R}_i^{r,j} + P_i^h \hat{C}_i^{r,j} + P_i^m C_i^{r,j}) \leq & \sum_i P_i^m(\bar{Y}_i^{r,j} - \bar{Y}_i^{procured,j} - \hat{C}_i^{r,j}) \\
& + \sum_i P_i^h \hat{C}_i^{r,j} \\
& + \bar{P}_i^{support} \bar{Y}_i^{procured,j} \\
& + \bar{W}^{r,j} + \bar{F}^{r,j}_{rec} - F^{r,j}_{cost} \\
& + \bar{B}^{r,j}_{rec} - \bar{B}^{r,j}_{cost} \\
& - tax^{income,j} \cdot \bar{Y}^{r,j}_{na} \\
& - \overline{tax}_{na}{}^{excise} \bar{Y}^{r,j}_{na} \\
& - P^m_{na} \bar{V}^{r,j}_{na} \\
& - P^m_{na} \bar{C}^{*r,j}_{inp_{na}}
\end{aligned}$$

The self consumption, $\hat{C}^{r,j}$, has to be constrained by availability

$$\hat{C}_i^{r,j} \leq Y_i^{r,j} - \bar{Y}_i^{\text{procured},j}$$

(e) Urban Incomes

$$\sum_i (\bar{P}_i^{\text{rations}} \bar{R}_i^{u,j} + P_i^m C_i^{u,j}) = (1 - \text{tax}_{na}^{\text{income}} \bar{\alpha}_{uj}) \Big[ \sum_i (P_i^m - (1 + \bar{s}_{na}^{re}) \,\overline{\text{tax}}_{na}^{\text{excise}}) \,\bar{Y}_i^{u,j} \Big] - P_{na}^m \,\bar{V}_{na}^{u,j}$$

(ii) Government

(a) Government's objectives

The objectives of the government are, in order of priority, the following:

(i) Maintain a set of desired domestic prices $P^*$

(ii) Reach the target stock levels ST* (t)

(iii) Attain a certain perdetermined balance of trade.

(iv) Mobilize savings to the target level S*. The savings target is for the economy as a whole and does not refer to government savings alone.

These have to be realized subject to the various constraints on income and expenditure.

(b) Income

Government's income, $G_I$, comprises of net incomes from tariff, indirect taxes, direct taxes, and irrigation charges.

$$G_I = G_{\text{tariff}} + G_{it} + G_{dt} + G_{irr}$$

(i) Income from tariff on imports, $G_{\text{tariff}}$:

$$G_{\text{tariff}} = (\bar{P}^w - P^m) \Big\{ \bar{Y} + ST(t-1) - ST(t) - C_t - \bar{C}_{inp} - V_{vs} \Big\}$$

where $P^w$ is prices in the world market

$P^m$ is domestic market prices

$Y$ is domestic product

$ST^{\ell}(t)$ is stock at the end of period t

$C_t$ is total domestic demand for consumption

$C_{inp}$ is demand as next year's inputs for production

$V_{vs}$ is voluntary savings

(ii) Income from indirect taxes, $G_{it}$:

$$G_{it} = \overline{tax}^{excise} \; \bar{Y}^{r}_{na}$$

$$+ \; (1 + \bar{s}^{re}) \; \overline{tax}^{excise} \; \bar{Y}^{u}_{na}$$

$$+ \; \sum_{i} (P^{m} - \bar{p}^{support}) \; \bar{Y}^{procured,i}$$

$$- \; s_{na} \; P^{m}_{na} \; \bar{C}^{*r,j}_{inp_{na}}$$

(iii) Income from direct taxes:

$$G_{dt} = \sum_{j}\sum_{i} (tax^{income} \; \bar{\alpha}^{rj})(P^{m}_{i} - \overline{tax}^{excise}_{i}) \; \bar{Y}^{rj}_{i}$$

$$+ \sum_{j}\sum_{i} (tax^{income} \; \bar{\alpha}^{uj})(P^{m}_{i} - (1+\bar{s}^{re})\overline{tax}^{excise}_{i}) \; \bar{Y}^{uj}_{i}$$

$$+ \sum_{j}\sum_{z} \overline{tax}^{land}_{j} \; \bar{A}^{z,i}$$

where $tax^{income}$ is the average tax rate on income, and

$\alpha^{s,j}$ is the tax-rate factor for class j for introducing progression in tax rates.

(iv) Income from Irrigation charges, $G_{irr}$:

$$G_{irr} = \sum_{z} P^{r,canal} \; A^{z,canal}$$

(c) Constraint on Tax Rates

Though both income tax and excise tax rates are considered as policy variables, there is a desired ratio, $tax^{ratio}$ between direct and indirect tax incomes, which determines one tax rate when the other is given.

$$G_{dt} = tax^{ratio} G_{it}$$

(d) Government Expenditure

Government expenditure, $G_E$, consists of what it spends on public food distribution and price support program and or other public consumption.

$$G_E = \sum_i (-\bar{P}_i^{ration} \bar{R}_i + \bar{P}^{support} \bar{Y}_i^{procured} + P_i^m (Y_i^{govt} - \bar{Y}_i^{procured})$$

$$+ \sum_i P_i^m g_i^{-c} \bar{G}_c$$

where $\bar{Y}_i^{procured}$ is the amount of good i procured by government at the fixed support prices, $P_i^{support}$

$Y_i^{govt}$ is the total amount of good i obtained by the government

$G_c$ is public consumption

$g_i^c$ is the amount of good i required per unit public consumption

Public consumptions grows at a predetermined rate $\gamma$.

$$G_c(t) = (1+\gamma) G_c(t-1)$$

(e) Savings Target

Government policies are directed to see that the realized gross savings, S, equal the desired savings level, $S^*$.

$$S = S_g + \sum_j \sum_s S^{s,j}$$

$$S_g = G_I - G_E = \sum_i g_i^s S_g$$

where $S_g$ is public savings

$g_i^s$ is the amount of savings held in good i for every unit of total public saving.

(3) Market Equilibrium

(a) Prices

For market equilibrium the prices in the domestic market must clear the domestic markets. For an open economy these prices are also related to the world market prices. If quotas on import or export are not binding, domestic price will differ from the world price by the amount of tariff, but when the quotas are binding, the domestic prices will differ by an additional amount. However, we assume that the government imposes an adjustable levy which absorbs any premium due to quotas. This is not unreasonable when trade of critical items is monopolized by the state. Thus

$$P_i^m = \bar{P}_i^w + tax_i^{tariff,\ell} - tax_i^{tariff,r}$$

and

$$tax_i^{tariff,\ell}\ X_i = tax_i^{tariff,\ell}\ \bar{\ell}_i$$

$$tax_i^{tariff,n}\ X_i = tax_i^{tariff,n}\ \bar{r}_i$$

$$\bar{\ell}_i \leq X_i \leq \bar{P}_i$$

$$tax_i^{tariff,\ell},\ tax_i^{tariff,n},\ P_i^m \geqq 0$$

where $X_i$ is net export of good i (Good i is imported when $X_i$ is -ve)

$\bar{\ell}_i$ is limit on import of good i, where $\bar{\ell}_i \leq 0$, but is a minimum export target set for good i when $\bar{\ell}_i > 0$.

$\bar{r}_i$ is limit on export of good i, when $\bar{r}_i \geq 0$; but is aminimum import target for good i when $\bar{r}_i < 0$

$tax_i^{tariff,r}$ is tariff on export of good i when $X_i$ is positive, but is a subsidy paid to import good i when $X_i < 0$

$tax_i^{tariff,\ell}$ is tariff on import of good i when $X_i < 0$ but is a subsidy paid to export good i when $X_i > 0$.

It should be noted that on any good i either the lower or the upper quota is binding and thus only one of $tax_i^{tariff,r}$ and $tax_i^{tariff,\ell}$, is non-zero.

The world market prices $P^w$ are on domestic currency at a given exchange rate. It may be noted that in this model the exchange rate does not play as the real variables are neutral to it under a balance of trade equilibrium.

(b) Quantity Accounting

The demand for a good must be equal to its supply.

$$X_i = \bar{Y}_i + (1 - s_i^{st})\ \overline{ST}_i(t-1) - ST_i(t) - \bar{R}_i$$

$$- g_i^c\ \bar{G}_c(t) - g_i^s\ S_g(t)$$

$$- \sum_j (C_i^{r,j} - \bar{C}^{*r,j} - \bar{\bar{V}}_i^{r,j} - C_i^{u,j} - \bar{\bar{V}}_i^{u,j})$$

(c) The Balance of Trade

Finally the trade must balance or have a prespecified disequilibrium, F.

$$\sum_i P_i^w X_i = F$$

5.9 Module K. Capital Allocation and Accumulation

In the exchange module the levels of savings of the various sectors of the economy are determined. These savings are allocated to increase production capacity in the different sectors. In agriculture this is done through development of irrigation, both public and private, of infrastructure, and by mechanisation of agriculture and fisheries. Capacity creation in rural and urban non-agriculture is realized through capital accumulation.

Though development of infrastructure, roads, research, information and extension, is important for many reasons, it is difficult to measure its productivity. The allocation of resources to it is perhaps based on availability of resources and perceived opportunities. The investment infrastructure, $I_{infra}$, is estimated as follows:

$$I_{infra}(t) = I_{infra}(S_g, I_{infra}(t-1))$$

Expansion of canal irrigation results from large projects which form part of the long-term development plan. Thus the desired pace of development should be exogenously prescribed. Nonetheless, this pace may have to be slowed down if sufficient resources are not available. On the other hand, stepping up of the pace may be feasible only within limits. Thus investment in canal irrigation, $I_{canal}$, is given by,

$$I_{canal}(t) = I_{canal}(I^*_{canal}(t),\ S^*(t),\ S(t))$$

where $I_{canal}, I^*_{canal}(t)$ are actual and targeted investments in public irrigation development, and are actual and desired savings in the economy.

The investment in private irrigation, $I_{well}$, is a function of the rural savings, $S^r_v$, and the potential remaining to be developed.

$$I_{well} = \sum_z I^z_{well}(t) = \sum_z I^z_{well}\ (S^{r,z}_v(t),\ (\bar{A}^{z,w}_{max} - A^{z,w}_{(t)}))$$

where $\bar{A}^{z,w}_{max}$ is potential maximum area which can be irrigated from private irrigation in zone z.

$A^{z,w}$ is area irrigated from private irrigation sources in zone z.

The substitution of bullock by tractors may be taken to depend upon the shadow rental of bullok, the price of tractors and the availability of private savings. Alternatively, the need for tractors can be related to the level of outputs in the zone. The investment in tractors, then would be related to availability of bullocks and savings and need for tractors.

$$I^z_{tractors}\ (t) = I^z_{tractors}[(K^{z*}_{tractors}(t) - K^z_{tractors}(t-1)),$$

$$P^z Bulls(t),\ (S^z_v(t) - I^z_{well}(t)]$$

where

$I^z_{tractors}$, $K^z_{tractors}$ are investment and capital stock in the form of tractors

The remaining savings are allocated to fisheries, and urban and rural non-agriculture to equate marginal product of capital in the three sectors. In so doing the benefit of the subsidy given to rural non-agriculture is permitted.

$$I_{fisheries} + I^r_{na} + I^u_{na} = S - I_{infra} - I_{canal} - I_{well}$$

Once the investments are allocated the capacity creation for the next period is straightforward.

$$A^{z,canal}_{(t+1)} = A^{z,canal}_{(t)} + \frac{I_{canal}}{I^*_{canal}} \cdot \Delta A^{*z,canal}$$

$$A^{z,well}_{(t+1)} = A^{z,well}(t) + f(I^z_{well})$$

$$K^s_{na}(t+1) = K^s_{na}(t) + P^{(o)}_{na} \frac{I^s_{na}(t)}{P_{na}(t)} - \overline{RP}^s_{na}(t) \qquad s = r,u$$

$$K_{fish}(t+1) = K_{fish}(t) + \frac{P(o)_{na}}{P^{(t)}_{na}} \cdot I_{fish}(t) - \overline{RP}_{fish}(t)$$

where $\overline{RP}^s_{na}$ is capacity replacement needed in non-agriculture in sector s (=r, u).

## 5.10 Module G.3 Revise Tax Policy

Once the tax levels and incidence of tax on various classes is determined in the exchange module, it is possible to examine to what extent the tax burden has been "equitable".

The actual incidence of tax on rural and urban sector are examined and $tax^{land}$ is revised to adjust any discrepancy for the next period.

Finally the targeted levels of procurement of agricultural products are fixed for the next period.

$$Y^{procured}_{ag}(t+1) = Y^{procured}(Y^{procured}_{ag}(t), ST_{ag}, P^m_{ag})$$

## 5.11 Module D - Demographic Changes and Migration

### (1) Growth of Population

Models of population projections are readily available which require that the fertility rates are prescribed. The fertility rates would be exogenously specified at least in the initial phase. In fact even a simpler model could do. However, the growth rates should be specified by consumption expenditure classes so as to reflect in some way changing fertility and death rates with the level of consumption.

$$POP^r(t+1) = \sum_j POP^r_j(t)\ (1+\rho^r_j) - RUM(t)$$

$$POP^u(t+1) = \sum_j POP^u_j(t)\ (1+\rho^u_j) - RUM(t)$$

where $\rho_j^r$, $\rho_j^u$ are growth rates of rural and urban populations in expenditure class j, and RUM (t) is rural to urban migration in period t.

Population growth rates for different expenditure classes are not easy to obtain. International cross section analysis may be used as a possible solution.

(2) Rural and Urban Migration

The migration from rural to urban areas will be driven by the differences in urban and rural incomes.

$$RUM\ (t) = f\ (INC^u_{na},\ INC^r_{na} + INC_{ag},\ POP^r,\ POP^u)$$

## 5.12 Some Observations on the Model and Data Required

Once the new population and capacity levels are determined and the tax policies are revised, the computation for the next period can begin with module NA.

It may be noted that one of the outcomes of the exchange module is the quantity of goods offered for trade by the country at the given world prices. If these given world prices are altered then only the exchange module needs to be recomputed. The earlier modules are not directly affected by the world prices.

The complexity of the model described above is unavoidable if one wants to examine quantitatively the interactions of the different policy instruments described earlier and their implications on the various objectives of the government.

The data required for the model are considerable. However, the model is so structured as to be estimable with data which are for the most part currently collected in India, and in any case with data which in principle can be collected. In Parikh (1977) the types of data available in India are summarized.

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## LIST OF SYMBOLS

System of nomenclature generally followed:

### Subscripts

| | |
|---|---|
| ag,na | Refer to agricultural and non-agricultural sectors respectively. |
| c | Refers to crop or commodity or good. |
| s,B,c | Refer to the sex of the livestock, Bull and cow respectively. |
| a | Refers to animal type. |
| k | Refers to cultivator class by size of land cultivated. |

### Superscripts

| | |
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| z | Refers to agro-climatic zone. |
| well,canal,rf | Refer to source of water, well, canal or rainfed respectively. |
| r,u | Refer to rural and urban sector respectively. |
| s | Refer to sector (rural or urban) |
| * | Refers to expected, desired or targets or to values at expected prices |
| k | Refers to animal type, k (= cattle, buffalo). |
| $\tau$ | Refers to age of the animal at the beginning of the period in completed years. |

### In Parentheses

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| (t) | time period |
| (a,b,...) | argument of function |

### Nomenclature

| | |
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| ABC, abc | A string of capital or lower case letters refers to one variable. A Product of two variables is indicated by a "." between them when the absence of it may result in ambiguity. |

Variable Names

| | |
|---|---|
| A | Area in million hectares |
| C | Consumption, quantity |
| INC | Income |
| LS | Livestock |
| m | Labour hours |
| P | Prices |
| POP | Population |
| tax | tax rates |
| Tax | Amount of Tax |
| S | Savings |
| Y | Output, quantity |

All area variables are in million hectares

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| $A^{z}(t)$ | Cultivable area in zone z in period t. |
| $A^{z,w}(t)$, $A^{z,w}_{max}$ | Cultivable area in period t and maximum possible cultivable area in zone z with source of water w(= canal, well, ir (canal & well), rain). |
| $A^{z,w}_{c}$ (t) | Cultivable area devoted to crop c in zone z period t and water source w. |
| $B^{z}(t)$ | Bullock hours used per period in million bull hours in cultivation in zone z in period t. |
| $B^{z,w}_{c}(t)$ | Bullock hours used in cultivation of crop c in zone z,w in period t. |
| $BULLS^{z}(t)$ | Number of working bullock in millions in zone z in period t. |
| $B^{z,h}_{cost}(t)$ | Bullock rental cost incurred by the households of class h in zone z period t in million Rs. at current prices. This includes payments for own bullock used. |
| $B^{z,h}_{rec}$ (t) | Bullock rentals received by the households of class h in million Rs. at current prices in zone z period t. |

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| $b^{k,\eta}(\tau)$ | Bullock power potential in hours/period for a bull of age $\tau$ years under feeding regime $\eta$. |
| $b_c^{z,w}$ | Bullock hours used per hectare of crop c under water source w m zone z. |
| $b_s^{k,\tau}$ | Births per period of sex s of a female animal of type k and age $\tau$ years. |
| $cost_c^{z,canal}(t)$ | Cost of operating canal irrigation system in Rs. in zone z for a hectare devoted to crop c in current prices. |
| $c_{cost}^{z}(t)$ | Cost of cultivation in millions of Rs. at current prices in zone z period t. |
| $c_{inp_i}^{*z}(t)$, $c_{inp_i}^{z}(t)$ | Expected and actual costs of inputs of type i (= ag, na) in millions of Rs at current prices in zone z period t. |
| $c_{oth}^{z}(t)$ | Costs, other than those of inputs, of cultivation in millions of Rs. at current prices in zone z period t. |
| $\left.\begin{array}{l}[c_{feed,c}],\\ [c_{fodder,c}]\end{array}\right\}$ | Matrices of coefficients of feed and fodder outputs, sometimes as joint products in base year Rs per base year Rs worth of output of crop c. |
| $c_{ff}^{z}(t)$ | Total costs of feeds and fodders in zone z in millions of Rs. at current prices. |
| $CI^{*z}(t)$, $CI^{z}(t)$ | Expected and actual incomes of cultivators in zone z, respectively in millions of Rs. |
| $c_{inp_i}^{*z,h}(t)$, $c_{inp_i}^{z,h}(t)$ | Expected and actual inputs of good i for period t by households of class h in zone z in millions of Rs at base year prices. |
| $c_{inp_{na}}^{*r,j}(t)$ | Expected inputs of non-agriculture for period (t+1) to be procured in period t by rural households of class j in millions Rs. at base year prices. |
| $c_{t,i}^{s,j}(t)$ | Total consumption of good i in million Rs. at base year prices by consumers of sector s and class j. |
| $\{c_t(t)\}$, $\{c(t)\}$, $\{\hat{c}(t)\}$ | Vectors of total consumption, consumption purchased from market, and consumption from retained production by cultivators, respectively in millions of Rs. |
| $\{c_{inp}\}$ | Vector of goods to be procured in period t as inputs for production in period t+1 in million of Rs. |

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| $D^{s}_{t,i}$ | Demand schedules which give $C^{s}_{t,i}$ as functions of market prices $P^{m}$, and total expenditure on consumption, $E^{s}_{t}$, by a person in sector s. |
| $E^{s}_{t}(t)$ | Total expenditure on consumption by sector s in million Rs. |
| $f^{k\eta}_{is}(\tau)$ | Feed type i in base year Rs. given to animal type k (= cattle, buffalo) of sex s and age $\tau$ in completed years under feeding regime $\eta$. |
| $f^{a\eta}_{is}(\tau)$ | Same as $f^{k\eta}_{is}(\tau)$ but a ranger over all types of animals. |
| $f^{s}_{p}$ | Fraction of population in sector s (= u,r) to be covered by public food distribution. |
| $F^{z,h}_{cost}(t)$, $F^{z,h}_{rec}(t)$ | The cost of feeds and fodder paid and received, respectively, by households of type h in million of Rs. |
| $G_{v}(t)$ | Government consumption in million Rs. |
| $G_{E}(t)$ | Government expenditure in million Rs. |
| $G_{I}(t)$ | Government income in million Rs. |
| $G_{t}(t)$ | Government income in million Rs. from tax t (= tariff, it = indirect taxes, dt = direct taxes, irr = canal irrigation) |
| $g^{c}_{i}$ | Amount of good i required for unit public consumptions. |
| $g^{s}_{i}$ | Amount of good i required for unit public savings. |
| $H^{z,h}(t)$ | Number of households in millions in class h, i.e. owning $a_h$ hectares of land, in zone z. |
| $H^{z}_{ag}(t)$ | Number of agricultural households in millions in zone z. |

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| $I^{z}_{item}(t)$ | Investment in million Rs for item (= infrastructure, canal irrigation, well irrigation, fisheries). |
| $I^{s}_{na}(t)$ | Investment in million Rs. in non-agriculture in sector s. |
| $INC^{s,j}(t)$ | Income of class j of sector s in million of Rs. |
| $INC_{ag}(t)$ | Total income in agricultural sector in million of Rs. |
| $IN_{na}(t)$ | Non-agricultural output used as intermediate goods in agriculture in period t. |
| $IN^{s}_{ag}(t)$ | Agricultural output used as intermediate input in the non-agricultural sector located at s(= r, u). |
| $IW^{z*}(t)$ | Expected irrigation water in zone z in centimeters. |
| $KU^{s}_{na}(t)$ | Capital stock in million Rs. at base year prices, utilized in the production of non-agriculture in period t sector s. |
| $K^{s}_{na}(t)$ | Captial stock in million of base year Rs., available for the production of non- agriculture in period t sector s |
| $K^{z,w}_{c}(t)$ | Capital stock in Rs at base year prices used per hectare of crop c with water source w. |
| $K_{fish_i}(t)$ | Capital stock in million Rs. at base year prices in fishery production from source i (= marine, marine) |
| $K^{z,w}_{c}$ | Non irrigation capital employed per hectare of crop c in zone z, water source w. |
| $L^{s}_{na}(t)$ | Labour in millions of man years used in the production of non-agriculture in period t sector s. |
| $L^{z}_{ag}(t)$ | Available man years in millions for agriculture in zone z. |
| $L^{z,hired}_{c}(t)$ | Labour in millions of man years hired for cultivation of crop c in zone z. |
| $L^{z,w}_{c}$ | Labour used in million of man years in cultibation of crop c in zone z, water w. |

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| $LS_s^{k\tau}(t)$ | Livestock in millions of type k, sex s and age $\tau$ at the beginning of period t and surviving at the end of period t. |
| $LSS_s^{k,\tau}(t)$ | Livestock in millions of type k, sex s and age $\tau$ slaughtered on first day of period t. |
| $LS_a^{z,h}(t)$ | Livestock of type a held by household class h in zone z. |
| $LS_a^z(t)$ | Livestock of type a (= cattle, buffaloes, sheep, goats, pigs and poultry) in zone z in millions. |
| $I_c^{z,w}$ | Labour years used per hectare in cultivation of crop c in zone z, water w. |
| $m_{hk}^{z,j}(t)$ | Man years for agricultural work per period per household type hk (owning $a_h$ hectares but cultivating $a_k$ hectares) of description s (p = potential, o = utilized on own farm, w = hired for wages, t = total employed = o + w) |
| $m^{k\eta}(\tau)$ | Milk yield rate of animal type k ( = cow, buffalo) of age $\tau$ under feeding regime $\eta$ in Rs worth at base year price per period per animal. |
| $N_c^z$, $PH_c^z$, $K2O_c^z$ | Nitrogenous, phosphatic and potassic fertilizers applied in kg of nutrients per hectare of crop c. |
| $n_a^h$ | Proportion of livestock of type a in the aone held by household class h. |
| $P(t)$ | Price in Rs per rupee worth of product in base year. |
| $\left\{P_{ag}(t)^*\right\}$, $P_{na}^*(t)$, $P_c^*(t)$ | Desired market prices of agricultural products, non-agriculture and commodity c repsectively. |
| $P_{ag}^h(t)$ | Harvest prices, i.e. prices received by farmers |
| $P_{ag}^{support}(t)$, $P_{ag}^{ration}(t)$ | Minimum support price and ration shop issue price respectively |
| $P_{na}^{farmers}(t)$ | Price paid by farmers for non-agricultural inputs. |
| $\left\{P_{ag}^m(t)\right\}$, $P_{na}^m(t)$, $P_c^m(t)$ | Market price of agriculture, non-agriculture and commodity c. |

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|---|---|
| $\left\{P^{m}_{ag}(t)\right\}$ | Vector of market prices of agricultural products in Rs. per one rupee worth of base year output. |
| $P^{f}_{i}(t)$ | Price of fertilizer i (= N, $P_2O_5$,$K_2O$) in Rs./kg. |
| $P^{z}_{bulls}(t)$ | Shadow price of bullock hours in zone z. |
| $P^{z,canal}(t)$ | Irrigation changes in Rs per hectare of land irrigated from canals in zone z. |
| $POP^{s}(t)$ | Population in million in region s (= u,r) |
| $POP_{ag}(t)$, $POP_{na}(t)$ | Populations in millions in sector ag and na. |
| $PR^{r}_{na}(t)$, $PR^{ri}_{na}(t)$ | Profits from rural non-agriculture and profits accruing to household class i in millions of Rs at base year prices. |
| $pr^{h}$, $pr^{r}_{ag}$ | Share of profits from rural non-agriculture accruing to agticultural households of type h and to all agricultural households. |
| $pr_{i}$ | Share of profits from rural non-agriculture going to non-agricultural households of class i. |
| $[q^{z}_{hk}]$ | Matrix of distribution of households by size of land owned and cultivated. $h^{z}_{hk}$ is the proportion of all agricultural households in zone z who own $a_n$ hectares but cultivate themselves $a_k$ hectares. |
| $R^{s,j}_{i}(t)$ | Amount of good i given to class j, sector s in ration shops in millions of Rs at base year prices. |
| $\left\{R_{ag}(t)\right\}$ | Amounts distributed in nation shops in millions of Rs at base year prices. |
| $RW^{z*}(t)$ | Expected rain water in zone z in cms. |
| $r^{z}_{bull}(t)$ | Rental cost of bull services per hectare per period in Rs. |
| $r^{s}_{c}(t)$ | Amount of commodity c given per person in ration shop in sectors in Rs. in base year prices. |
| $S^{s,j}(t)$ | Savings in millions of Rs of class j in sector s. |
| $S^{r,z}_{v}(t)$ | Voluntary savings in millions of Rs in zone z. |
| $S(t)$ | Actual aggregate savings/investment level in period t. |

| | |
|---|---|
| $S^*(t)$ | Desired aggregate gross savings/investment level in period t. |
| $S_g$ | Public savings in million Rs. |
| $\{ST^*_{ag}(t)\}, \{ST_{ag}(t)\}$ | Desired and actual stocks of agricultural products at end of period t in millions Rs at base year prices. |
| $s^{st}_{ag}$ | Rate of loss of stocks on storage per period. |
| $s^{re}$ | Subsidy rate in excise tax to rural non-agriculture. |
| $s_{na}$ | Subsidy rate to agricultural users of non-agricultural inputs as a fraction of price. |
| $SW_{ag}$ | Share of wages in rural non-agriculture that accrues to primarily agricultural households. |
| $Tax^{direct}(t)$ | Revenue from direct taxes in millions of Rs. |
| $Tax^{indirect}(t)$ | Revenue from indirect taxes in millions of Rs. |
| $tax^{ratio}$ | Ratio of incidence of direct taxes on non-agricultural income to incidence of various implicit taxes on agricultural income. |
| $tax^{s-excise}_{na}(t)$ | Rate of excise tax on non-agricultural output in sector s in current Rs per a rupee worth of output in base year price. |
| $tax^{z,land}(t)$ | Rate of land revenue tax in zone z in Rs. per hectare of land. |
| $tax^{income}(t)$ | Rate of income tax in Rs. per rupee of non-agricultural income. |
| $Tax^{z,land}_h(t)$ | Amount of land revenue tax paid in million of Rs. by households of class h in zone z. |
| $Tax^{z,canal}(t)$ | Amount paid in millions of Rs. by households in zone z for canal irrigation. |
| $Tax^{z,h}(t)$ | Taxes paid in millions of Rs. by households of class h in zone z. |
| $t^z_{sc}$ | Tenant's share, as a fraction, of cost of cultivation. |
| $t^z_{sp}$ | Tenant's share, as a fraction, of products cultivation. |

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| $v^z_{c_i}$ | Fixed costs excluding cost of land, capital, labour, bullocks, irrigation and fertilizers of cultivating crop c in zone z for inputs purchased from sector i (i = ag, na) in Rs/hectare. |
| $v_i^{z,well}$ | Non-capital costs of inputs purchased from sector i (i = ag, na) for irrigation from private soruces in Rs./hectare |
| $V_s^{k,\tau}(t)$ | Value at beginning of period t of animal type k (k = cattle, buffalo), sex s (= Bull, cow) of age $\tau$ at the beginning of period t in Rs/animal. |
| $V_i^{s,j}(t)$ | Voluntary savings of class j sector s held in the form of good i in millions of Rs. at base year prices. |
| $\left\{V_{vs}(t)\right\}$ | Voluntary savings of different products in million Rs. at base year prices. |
| $w^s$ | Wage rate in Rs per man year in sector s |
| $w^r$ | Wage rate in Rs. per man year in rural areas |
| $W^{hk}(t)$ | Wages paid by the households in class hk in Rs millions at current prices. |
| $W^h(t)$ | Wages earned by the household of class h in Rs. millions at current prices. |
| $W^r_{na}(t)$ | Share of wages in the product of rural non-agriculture |
| $W^{ri}_{na}(t)$ | Wage income of non-agricultural households of i th income class in Rs. millions at current prices. |
| $X_i$ | Net export of good i in million Rs. at base year price. |
| $\left\{Y_{ag}(t)\right\}$, $Y_c(t)$ | Vector of outputs of agricultural products and output of commodity c in millions Rs. at base year prices. |
| $Y^s_{na}(t)$ | Output on non-agriculture in millions of base year Rs. in sector s. |
| $\left\{Y^z_{feed}(t)\right\}$, $Y^z_{feed_i}$ | Vector of output of feeds and output of feed i in zone z in million Rs. at base year prices. |
| $Y^z_{fodder}(t)$ | Output of fodder in million Rs. at base year prices. |

| | |
|---|---|
| $y_c^{levy}$ | Rate of levy in Rs. at base year prices per hectare of crop c. |
| $y_c^{z,w}$ | Yield (output per hectare) in Rs at base year prices of crop c water source w (w = canal, wells, rainfed, irr = canal & wells) in zone z. |
| $y_{oc}^{z,w}$ | Yield without fertilizer application. |
| $y_{ap}$ | Products resulting from one animal of type a in Rs. per period per animal at base year prices. |
| $\left\{Y_{ag}^{govt}\ (t)\right\}$ | Outputs of agricultural products in million of base year Rs. that the government commands in period (t). |
| $\left\{Y_{ag}^{procured}\right\}, Y^{procured}$ | Amount of agricultural products, and commodity c, respectively procured by government at support prices. |
| $Y_{ap}^{h}(t)$ | Endowments of animal products in million Rs. at base year prices from animal type a, accruing to household class h. |
| $Y_{na}^{r,h}\ (t)$ | Endowment of non-agricultural output in million Rs at base year prices from rural non-agriculture to household type h. |